TRUCK SHOP MANUAL
1989
VOLUME A
Volume 1 of 2

LIGHT DUTY TRUCK
E, F-150 through 350, F-Super Duty, Bronco
BODY/CHASSIS/ELECTRICAL

Subject	Group
Automatic Transmission (7000)	17
Brakes (2000)	12
Clutch and Manual Transmission (7000)	16
Driving Axles and Driveshafts (4000)	15
Identification Codes	10
Noise, Vibration and Harshness Diagnosis	18
Roadability	19
Steering (3000)	13
Suspension (3000 & 5000)	14
Wheels and Tires (1000 & 2000)	11

Ford Parts and Service Division
Publications Department

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Shop Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

NOTES, CAUTIONS, AND WARNINGS

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific operation. Place wood blocks (4" x 4" or larger) to the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts, when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

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foreword . . .

This 1989 Truck Shop Manual has been prepared to provide information covering normal Body, Chassis and Electrical service repairs and maintenance for the 1989 Bronco, Econoline (E-150 through E-350), F-150 through F-350 and F-Super Duty Ford Trucks manufactured in the United States and Canada.

Engine, Pre-Delivery, Maintenance and Lubrication service repairs are covered in the 1989 Light Truck Engine Manual, the 1989 Engine/Emissions Diagnosis Manual and the 1989 Truck Pre-Delivery Manual.

This manual is divided into Groups covering a general system. The basic part number for components covered in the Group is also included in parenthesis after the Group number. For example:

Example:	Brakes	Group 12	(2000)
	General System Covered in Group	Group Number	Basic Part Number for Brake System Components

Some components covered within a Group do not have the same basic part number. In these cases, more than one basic part number will appear on the Group index.

Example:	Suspension	Group 14	(3000	&	5000)
	General System Covered in Group		Basic Part Number for Suspension Components		Basic Part Number for Exhaust Components

Within each Group, the information is further divided into smaller Sections. There is one Section for each component in the system, as well as a General Service Section in some Groups to cover procedures common to several Sections within the Group. In general, each Section contains the Description, Operation, Diagnosis and Testing, Removal and Installation and Disassembly and Assembly procedures for the component covered in the Section. Diagnosis Charts are also included in some Sections to help you systematically locate and correct problems encountered. In most cases, specifications are included at the end of each Section.

To aid in locating specific items in this manual, use the Alphabetical Subject Index in the back of the manual, or the Group and Section Index on the following pages.

As a further aid there is an index on the first page of each Group listing the Section title and Basic Part number for components covered within the Group. The first page of each Section contains an index to locate service operations covered in that Section. This Group-Section breakdown is also indicated in the page number located at the top of each page.

Example: 11-02-21 = (Group) 11 — (Section) 02 — (Page) 21

The descriptions, testing procedures, and specifications in this manual were in effect at the time the manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design or testing procedures without notice and without incurring obligation. Any reference to brand names in this manual is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents if available may be used. The right is reserved to make changes at any time without notice.

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Truck Shop Manual Cross Reference Index

Volume	Content	Vehicle Lines
A	Body, Chassis, Electrical	Bronco, Econoline (E-150 through E-350) and F-150 through F-350, F-Super Duty
B	Engine	Bronco, Econoline (E-150 through E-350) and F-150 through F-350, F-Super Duty
D	Body, Chassis, Electrical	F-, FT-, B-, C-600 through 8000 Series
E	Engine	F-, FT-, B-, C-600 through 8000 Series
F	Pre-Delivery, Hoisting and Jacking	Car Models and Truck Series
H	Engine/Emissions Diagnosis	Car Models and Truck Series

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Table Of Contents

Group Index

Automatic Transmission (70000) 17
Brakes (2000) 12
Clutch and Manual Transmission (7000) 16
Driving Axles and Driveshafts (4000) 15
Identification Codes 10
Noise, Vibration and Harshness Diagnosis 18
Roadability 19
Steering (3000) 13
Suspension (3000 & 5000) 14
Wheels and Tires (1000 & 2000) 11

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Table Of Contents

Section Index

Automatic Overdrive Transmission 17-20
Borg-Warner 13-56 Electronic Shift Transfer Case 16-80
Borg-Warner 13-56 Transfer Case — Manual Shift 16-81
Borg-Warner 1345 Transfer Case 16-86
Brake Booster Vacuum Pump — 7.3L Diesel Engine 12-56
Brake Pedal, Master Cylinder and Valves 12-30
Clutch 16-02
C6 Automatic Transmission 17-10
C300N Hydraulic Power Steering Gear — Bendix 13-48
Dana Model 44 and 50 Front Drive Axles 15-34
Disc Brakes — Light and Heavy Duty — Sliding Caliper 12-24
Driveshaft — Double Cardan-Type U-Joint 15-66
Driveshaft — Single Type U-Joint 15-61
Drum Brakes — Single Cylinder, Dual Piston 12-02
E4OD Automatic Transmission 17-09
Ford Limited-Slip Differential 15-43
Front Driveshaft 15-67
Front Driving Axle — Dana 60 Monobeam 15-32
Front Suspension — Twin I-Beam/Solid I-Beam 14-21
Front Suspension — 4-Wheel Drive 14-22
General Automatic Transmission Service 17-01
General Clutch Service 16-01
General Driveshaft Service 15-60
General Driving Axle Service 15-01
General Hydraulic Brake Service 12-01
General Manual Transmission Service 16-10
General Steering Service 13-01
General Suspension Service 14-01
General Wheel and Tire Service 11-01
Hydraulic Clutch System 16-04
Hydro-Boost Brake Booster 12-57
Identification Codes 10-00
Integral Carrier Axle — Ford 10.25 Inch Ring Gear 15-09

Continued

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Table Of Contents

Section Index

Integral Carrier Axle — 8.8 Inch Ring Gear 15-08
Integral Carrier Rear Axle — Dana 15-05
Integral Power Steering Gear — Ford 13-41
Limited-Slip Differential — Dana 15-42
Lubrication Charts and Lubricant Specifications 10-03
Maintenance 10-02
Model S5-42 ZF Manual Transmission 16-34
M5OD Five-Speed Manual Overdrive Transmission 16-20
Noise, Vibration and Harshness Diagnosis 18-01
Parking Brake — Cable Actuated, Rear Wheels and Transmission Mounted 12-70
Power Steering Pump — C-II 13-53
Power Steering Pump — Saginaw 13-52
Power Steering Pump — ZF 13-57
Rear Antilock Brakes 12-31
Rear Suspension — Leaf Springs 14-31
Roadability 19-01
Shift Control Linkage 17-02
Steering Column — Shift Rod Within Tube 13-06
Steering Column — Stripped Chassis Models 13-07
Steering Linkage 13-24
Towing 10-04
Traction-Lok Differential — Ford 15-41
Vacuum Brake Booster — Single Diaphragm — Dash-Mounted (Bendix) 12-50
Vacuum Brake Booster — Tandem Diaphragm — Dash-Mounted (Bendix) 12-52
Warner T-18 Four-Speed Transmission 16-23
Wheel Hubs and Bearings — Front Wheel Drive 11-12
Wheel Hubs and Bearings — Rear Dana Full Floating Axle 11-14
Wheel Hubs and Bearings — Rear (Semi-Floating Axle) 11-11
Wheels and Tires 11-02
Wheels, Hubs and Bearings — Front (Except Front Drive) 11-10

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GROUP 10 IDENTIFICATION CODES

SECTION TITLE	PAGE
HOISTING, JACKING AND TOWING	10-04-1
IDENTIFICATION CODES	10-00-1
LUBRICATION CHART AND LUBRICANT SPECIFICATIONS	10-03-1
MAINTENANCE	10-02-1

SECTION 10-00 Identification Codes

SUBJECT	PAGE
GENERAL INFORMATION	
Build Date Stamp Locations	10-00-3
Vehicle Data	10-00-3
Vehicle Identification Number (VIN)	10-00-1
Vehicle Safety Compliance Certification Label	10-00-1
VEHICLE APPLICATION	10-00-1
VEHICLE IDENTIFICATION NUMBER (VIN) Codes	10-00-5

VEHICLE IDENTIFICATION

E-150 Through E-350, F-150 Through F-350, F-Super Duty Series, and Bronco Vehicles.

GENERAL INFORMATION

Vehicle Safety Compliance Certification Label

The English Safety Compliance Certification Label (Figs. 1 and 2), is attached to the drivers door lock pillar. The French Safety Compliance Certification Label is attached to the door latch edge on the passenger's side door (Fig. 1). The label contains the name of the manufacturer, the month and year of manufacture, the certification statement, and the Vehicle Identification Number. The label also contains Gross Vehicle Weight Ratings, Wheel and Tire data, and information codes for additional vehicle data.

Vehicle Identification Number (VIN)

Refer to Fig. 3

A seventeen digit combination of numbers and letters forms the Vehicle Identification Number (VIN). The VIN is stamped on a metal tab that is riveted to the instrument panel close to the windshield. The VIN number is viewable by looking through the front windshield on the driver's side. The VIN number is also found on the Safety Compliance Certification Label.

By looking at the seventeen digit VIN number a variety of information about the vehicle can be determined. The first three digits identify the manufacturer and the vehicle make and type. The fourth digit determines the Gross Vehicle Weight Rating (GVWR-Class) and Brake System for Ford completed Trucks and MPV's. For Buses and incompleted vehicles, the fourth digit determines the brake system (only). Digits five, six and seven identify the model or line, series, chassis, and cab or body type. The eighth digit points out the particular engine found in the vehicle. Digit nine is the VIN check digit. The tenth digit identifies the model year of a Ford-completed vehicle, or the model year of the incomplete vehicle, if sold by Ford as an incomplete vehicle. The eleventh digit determines the assembly plant. Digits twelve through seventeen make up the sequence serial and warranty number. Digit twelve uses the letter "A" until the production or sequence of 99,999 units (digits thirteen through seventeen) is reached. Letter "A" then becomes "B" for the next production sequence of vehicles.

Refer to Fig. 3 to help in further explanation of the Vehicle Identification Number (VIN).

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SAFETY COMPLIANCE CERTIFICATION LABELS
COMPLETE VEHICLES

(UNITED STATES)

MFD. BY FORD MOTOR CO. IN U.S.A.
DATE: 2/88 GVWR: 4900 LB/2222 KG
FRONT GAWR: 2684 LB
1217 KG WITH TIRES
P195/75R15SL
15x6.0 JK RIMS
AT 35 PSI COLD
REAR GAWR: 3750 LB
1700 KG WITH TIRES
P195/75R15SL
15x6.0 JK RIMS
AT 35 PSI COLD
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE
VEHICLE IDENTIFICATION NO.
1FTBF15G5 KLA00000
TYPE TRUCK
EXTERIOR PAINT COLORS DSO
WB | TYPE GVW | BODY | TRANS | AXLE | TAPE | SPRING

(CANADA)

MFD. BY FORD MOTOR CO. OF CANADA LTD.
DATE: GVWR:
FRONT GAWR: WITH TIRES RIMS
AT PSI COLD
REAR GAWR: WITH TIRES RIMS
AT PSI COLD
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE
VEH. IDENT. NO.
TYPE UTILIZE SAME TYPE DATA AS U.S.A.
EXTERIOR PAINT COLORS DSO
WB | TYPE GVW | BODY | TRANS | AXLE | TAPE | SPRING
MADE IN CANADA

(QUEBEC)

FABR. AUX E-U PAR LA FORD MOTOR CO.
DATE: PNBV:
PNBE AV: PNBE AR:
AVEC
◂PNEUS▸
◂JANTES▸
A LB/PO² A FROID A LB/PO² A FROID
CE VEHICULE EST CONFORME A TOUTES LES NORMES FEDERALES DE SECURITE DES V.A. EN VIGUEUR A LA DATE DE FABR. INIQUEE CI-DESSUS.
N° D'IDENT. DU VEH.
TYPE
COULEUR N° COMM SPEC.
EMPATT. | TYPE/PBV | CARR | TRANSM. | PONT | BANDE | RESSORT

(QUEBEC)

FABR. PAR FORD DU CANADA LIMITEE
DATE: PNBV:
PNBE AVANT: PNBE ARRIERE:
AVEC
◂PNEUS▸
◂JANTES▸
A LB/PO² A FROID A LB/PO² A FROID
CE VEHICULE EST CONFORME A TOUTES LES NORMES FEDERALES DE SECURITE DES V.A. EN VIGUEUR A LA DATE DE FABR. INIQUEE CI-DESSUS.
N° D'IDENT. DU VEH.
TYPE
COULEUR N° COMM SPEC.
EMPATT. | TYPE/PBV | CARR | TRANSM. | PONT | BANDE | RESSORT
MADE IN CANADA

FOR VEHICLES MFD IN U.S.A. FOR QUEBEC, CANADA.

FOR VEHICLES MFD. IN CANADA FOR QUEBEC, CANADA.

INCOMPLETE VEHICLES

THE INCOMPLETE VEHICLE RATING DECAL IS INSTALLED ON THE DRIVER'S DOOR LOCK PILLAR IN PLACE OF THE SAFETY COMPLIANCE CERTIFICATION LABEL.



DECAL APPLIED TO ALL CANADIAN BUILT UNITS AND ALL U.S.A. BUILT UNITS SOLD IN CANADA

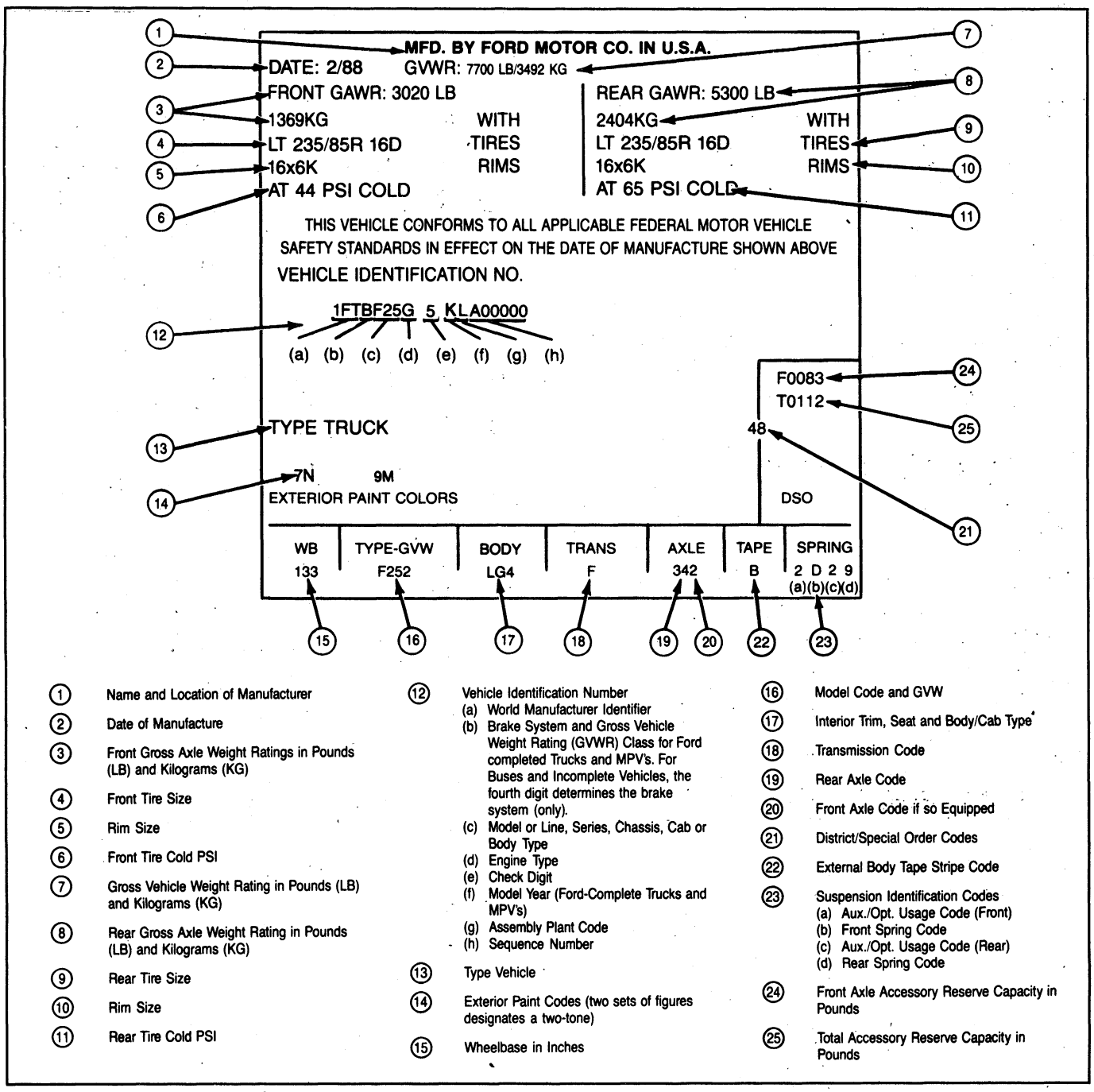
INCOMPLETE VEHICLE MANUFACTURED BY
GVWR: 3020 LB/1369 KG
VEHICLE IDENTIFICATION NUMBER 1FTBF25G5 KLA00000

EXTERIOR PAINT COLORS 51					48 DSO	
WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	SPRING 2D29
133	F270	AB4	F	38	B	1988

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FIG. 1 Typical Truck Safety Compliance Certification Labels and Vehicle Rating Decal

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1. Name and Location of Manufacturer
2. Date of Manufacture
3. Front Gross Axle Weight Ratings in Pounds (LB) and Kilograms (KG)
4. Front Tire Size
5. Rim Size
6. Front Tire Cold PSI
7. Gross Vehicle Weight Rating in Pounds (LB) and Kilograms (KG)
8. Rear Gross Axle Weight Rating in Pounds (LB) and Kilograms (KG)
9. Rear Tire Size
10. Rim Size
11. Rear Tire Cold PSI
12. Vehicle Identification Number
    (a) World Manufacturer Identifier
    (b) Brake System and Gross Vehicle Weight Rating (GVWR) Class for Ford completed Trucks and MPV's. For Buses and Incomplete Vehicles, the fourth digit determines the brake system (only).
    (c) Model or Line, Series, Chassis, Cab or Body Type
    (d) Engine Type
    (e) Check Digit
    (f) Model Year (Ford-Complete Trucks and MPV's)
    (g) Assembly Plant Code
    (h) Sequence Number
13. Type Vehicle
14. Exterior Paint Codes (two sets of figures designates a two-tone)
15. Wheelbase in Inches
16. Model Code and GVW
17. Interior Trim, Seat and Body/Cab Type
18. Transmission Code
19. Rear Axle Code
20. Front Axle Code if so Equipped
21. District/Special Order Codes
22. External Body Tape Stripe Code
23. Suspension Identification Codes
    (a) Aux./Opt. Usage Code (Front)
    (b) Front Spring Code
    (c) Aux./Opt. Usage Code (Rear)
    (d) Rear Spring Code
24. Front Axle Accessory Reserve Capacity in Pounds
25. Total Accessory Reserve Capacity in Pounds

FIG. 2 Typical Truck Safety Compliance Certification Label

Refer to the code definition portion of this Section for specific definitions of the numbers and letters of the Vehicle Identification Number (VIN).

Build Date Stamp Locations

The vehicle build date stamp is located as follows: On Bronco and Light Trucks (F-150—F-250—F-350) the vehicle build date is stamped on the front surface of the radiator support on the passengers side of the vehicle. On Econoline vehicles (E-150—E-250—E-350), the build date is stamped on top of the radiator support. Following is a sample of the four digit number that indicates the month and day of build.

Actual Date of Build

Date Stamp on Vehicle

January 24 0124

October 21 1021

Yellow ink is used for the date stamp. When the marking surface is painted the body color, the date stamp will be marked in red ink. Units from the Ontario Truck Plant (Code C) will be marked with silver ink.

Vehicle Data

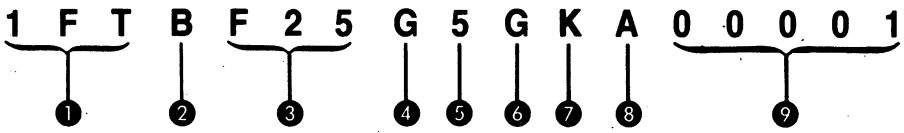
The Vehicle Data appears on the Safety Compliance Certification Label on the second and third lines following the identification number. The code set (two

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numbers, or a number and letter) above COLOR identify the exterior paint color (two sets of codes designate a two-tone). The three digits under W.B. designate the wheelbase in inches. The letter and three digits under TYPE/G.V.W.R. designate the truck model within a series and the gross vehicle weight rating. The letters and/or numeral under BODY designate the interior trim, seat and body type. The transmission installed in the vehicle is identified under TRANS by an alphabetical code. A letter and a number or two numbers under AXLE identify the rear axle ratio (when required, a letter is also stamped or number after the rear axle code to identify the front axle). The letters and/or numerals under TAPE designate the external bodyside tape stripe. The spring usage codes for the vehicle is identified under SPRING.

A two-digit number is stamped above D.S.O. to identify the district which ordered the vehicle. If the vehicle is built to special order (Domestic Special Order, Foreign Special Order, Limited Production Option, or other special order), the complete order number will also appear above D.S.O. The following charts list the various vehicle data codes.

SAMPLE VIN NUMBER



1. Position 1, 2 and 3 — Manufacturer, Make and Type (World Manufacturer Identifier)
2. Position 4 — Brakes System/GVWR Class for Ford-completed Trucks and MPV's. For Buses and Incomplete Vehicles, Brake System (only).
3. Position 5, 6 and 7 — Model or Line, Series, Chassis, Cab or Body Type
4. Position 8 — Engine Type
5. Position 9 — Check Digit
6. Position 10 — Model Year (Ford-completed vehicles)
7. Position 11 — Assembly Plant
8. Position 12 — Constant "A" until sequence number of 99,999 is reached, then changes to a constant "B" and so on
9. Position 13 through 17 — Sequence number — begins at 00001

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VEHICLE IDENTIFICATION NUMBER (VIN) Codes

VEHICLE IDENTIFICATION NUMBER (VIN) CODES

WORLD MANUFACTURER IDENTIFIER (VIN POSITIONS 1, 2 AND 3)

1FT BF25G5 K LA00001

VIN Code	Manufacturer	Make	Type
1FM	Ford Motor Company, USA	Ford	Multi-Purpose Passenger Vehicle (MPV)
1FT	Ford Motor Company, USA	Ford	Truck (Complete Vehicle)
1FD	Ford Motor Company, USA	Ford	Incomplete Vehicle (IV)
1FC	Ford Motor Company, USA	Ford	Basic (Stripped) Chassis
1FB	Ford Motor Company, USA	Ford	Bus
1FF	Ford Motor Company, USA	Ford	Motor Vehicle Equipment without Engine/Powertrain (Glider)
2FM	Ford Motor Company of Canada, Ltd.	Ford	MPV
2FT	Ford Motor Company of Canada, Ltd.	Ford	Truck (Complete Vehicle)
2FD	Ford Motor Company of Canada, Ltd.	Ford	Incomplete Vehicle
2FC	Ford Motor Company of Canada, Ltd.	Ford	Basic (Stripped) Chassis
2FB	Ford Motor Company of Canada, Ltd.	Ford	Bus
2FF	Ford Motor Company of Canada, Ltd.	Ford	Motor Vehicle Equipment without Engine/Powertrain (Glider)
3DF	Ford Motor Company of Mexico	Ford	Incomplete Vehicle (IV)

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BRAKE SYSTEM AND GVWR CLASS FOR TRUCKS AND MPV'S — BRAKE SYSTEM (ONLY) FOR BUSES AND INCOMPLETE VEHICLES (VIN POSITION 4)

1FT B F25G5KLA00001

BRAKE SYSTEM	GVWR CLASS	GVWR RANGE	VIN CODE
Hydraulic	Class A	Not greater than 3,000 pounds	A
Hydraulic	Class B	3,001 — 4,000 pounds	B
Hydraulic	Class C	4,001 — 5,000 pounds	C
Hydraulic	Class D	5,001 — 6,000 pounds	D
Hydraulic	Class E	6,001 — 7,000 pounds	E
Hydraulic	Class F	7,001 — 8,000 pounds	F
Hydraulic	Class G	8,001 — 8,500 pounds	G
		8,501 — 9,000 pounds	H
Hydraulic	Class H	9,001 — 10,000 pounds	J
Hydraulic	Class 3	10,001 — 14,000 pounds	K
Hydraulic	Class 4	14,001 — 16,000 pounds	L
Hydraulic	Class 5	16,001 — 19,500 pounds	M

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MODEL OR LINE, SERIES, CHASSIS, CAB OR BODY TYPE (VIN POSITIONS 5, 6, AND 7)

1FTB F25 G5KLA00001

VIN Code		Line	Series	ChassisType	Cab or Body Type	Vehicle Type ①
Club Wagon	Super Wagon					
E11	—	Club Wagon XL	E150	4x2	Club Wagon	MPV
E21	—	Club Wagon XL	E250	4x2	Club Wagon	MPV or Bus ⓐ
—	S31	Club Wagon XL	E350	4x2	Super Wagon	MPV or Bus ⓐ

Memo: One of the following optional exterior nameplates (indicating different trim levels) may also be affixed to the vehicle in addition to the Club Wagon XL nameplate:
●XLT ●No Nameplate (Trim credit option-deletes XL trim components) ⓐExcludes School Bus

Regular Van	Super Van					
E14	S14	Econoline	E150	4x2	Cargo Van — Regular Van/Super Van	Truck or IV
E24	S24	Econoline	E250	4x2	Cargo Van — Regular Van/Super Van	Truck or IV
E34	S34	Econoline	E350	4x2	Cargo Van — Regular Van/Super Van	Truck or IV
Other						
E37	—	Econoline	E350	4x2	Commercial Cutaway	IV
E30	—	Econoline	E350	4x2	RV Cutaway	IV
E39	—	Econoline	E350	4x2	Commercial Basic (Stripped) Chassis	IV
E33	—	Econoline	E350	4x2	RV Basic (Stripped) Chassis	IV

①"MPV" means Multi-Purpose Vehicle. "IV" means Incomplete Vehicle. "Truck" means Complete Vehicle.
Memo: For all Econoline except Basic (Stripped) Chassis, the optional exterior nameplate "XL" (indicating trim level) may also be affixed to the vehicle in addition to the Econoline nameplate.
Note: All 1988 model Commercial and RV Basic (Stripped) Chassis incomplete vehicles are designated by a "1FC" or "2FC" World Manfacturer Identifier (WMI) code. The RV Basic (Stripped) Chassis is available only on a Special Order Basis.

VIN Code	Line	Series	Chassis Type	Cab or Body Type	Vehicle Type ①
U15	Bronco	U150	4x4	Bronco	MPV

Memo: One of the following optional exterior nameplates (indicating higher trim levels) may also be affixed to the vehicle in addition to the Bronco nameplate:
● XLT ● Eddie Bauer

Regular Cab	Super Cab or Crew Cab					
F14	X14	F-Series	F150	4x4	Pickup — Regular Cab/Super Cab	Truck
F15	X15	F-Series	F150	4x2	Pickup — Regular Cab/Super Cab	Truck
F25	X25	F-Series	F250	4x2	Pickup — Regular Cab/Super Cab	Truck
F26	X26	F-Series	F250	4x4	Pickup — Regular Cab/Super Cab	Truck
F35	W35X35	F-Series	F350	4x2	Pickup — Regular Cab/Crew Cab	Truck
F37	—	F-Series	F350	4x2	Regular Cab (Chassis Cab)	IV
F36	W36	F-Series	F350	4x4	Pickup — Regular Cab/Crew Cab	Truck
F38	—	F-Series	F350	4x4	Regular Cab (Chassis Cab)	IV
F47	—	F-Series	F-Super Duty	4x2	Regular Cab (Chassis Cab)	IV
F53	—	F-Series	F-Super Duty	4x2	RV Basic Stripped Chassis	IV
F59	—	F-Series	F-Super Duty	4x2	Commercial Basic Stripped Chassis	IV

① "MPV" means Multi-Purpose Passenger Vehicle. "IV" means Incomplete Vehicle.
Memo: One of the following optional exterior nameplates (indicating higher trim levels) may also be affixed to the vehicle in addition to the F-Series nameplates:
● XL ● XLT Lariat ● Explorer (excluding Crew Cab and Chassis Cab)
Note: Special Order (DSO) units will be coded with the appropriate series VIN codes listed above.

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ENGINE TYPE, DISPLACEMENT, CYLINDERS, FUEL TYPE, AND MANUFACTURER (VIN POSITION 8)

1 F T B F 2 5 [G] 5 K L A 0 0 0 0 1

VIN Code	Displacement		Cylinders	Fuel	Manufacturer
	Liter	CID			
Y	4.9	300	I-6	Gasoline	Ford
N	5.0	302	V-8	Gasoline	Ford
H	5.8	351	V-8	Gasoline	Ford
G	7.5	460	V-8	Gasoline	Ford
M	7.3	445	V-8	Diesel	Navistar

CY2380-2H

CHECK DIGIT FOR ALL VEHICLES (VIN POSITION 9)

1 F T B F 2 5 G [5] K L A 0 0 0 0 1

CY2381-1H

VEHICLE MODEL YEAR FOR FORD-COMPLETED VEHICLES (VIN POSITION 10)

1 F T B F 2 5 G 5 [K] L A 0 0 0 0 1

VIN Code	Year
K	1989
L	1990
M	1991
N	1992

CY2382-1H

ASSEMBLY PLANT CODES (VIN POSITION 11)

1 F T B F 2 5 G 5 K [L] A 0 0 0 0 1

VIN Code	Vehicle Assembly Plant — Name and Location
C	Ontario Truck: Oakville, Ontario
H	Lorain: Lorain, Ohio
J	Monterrey, N.L.: Mexico
K	Kansas City: Claycomo, Missouri
L	Michigan Truck: Wayne, Michigan
N	Norfolk: Norfolk, Virginia
P	Twin Cities: St. Paul, Minnesota
U	Louisville: Louisville, Kentucky

CY2383-1H

PRODUCTION SEQUENCE NUMBER (VIN POSITIONS 12 THROUGH 17)

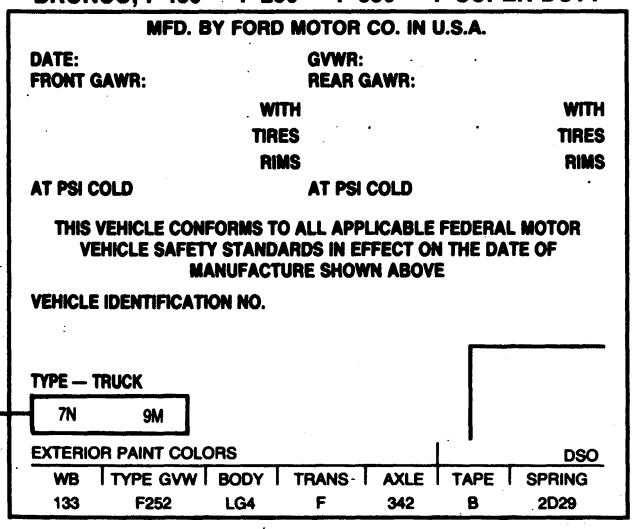
1 F T B F 2 5 G 5 K L [A 0 0 0 0 1]

SEQUENCE NUMBER
A 00001 — A 99,000
B 00001 — B 99,999
and so on.

CY2384-1H

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

EXTERIOR PAINT COLOR CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY



BRONCO EXTERIOR PAINT COLOR CODES

Code	Color
1C	Black
1D	Smoke Metallic
1G	Light Smoke Metallic
2D	Medium Scarlet
2H	Medium Cabernet
7H	Bright Regatta Blue Metallic
7N	Dark Shadow Blue Metallic
9M	White
9N	Desert Tan Metallic
9T	Light Chestnut
42	Alpine Green Metallic
95	Dark Chestnut Metallic
99	Prime
Fiberglass Roof Colors	
A	Black
B	Blue
H	Desert Tan
W	White

NOTE — TWO SETS OF CODES INDICATE TWO-TONE PAINT

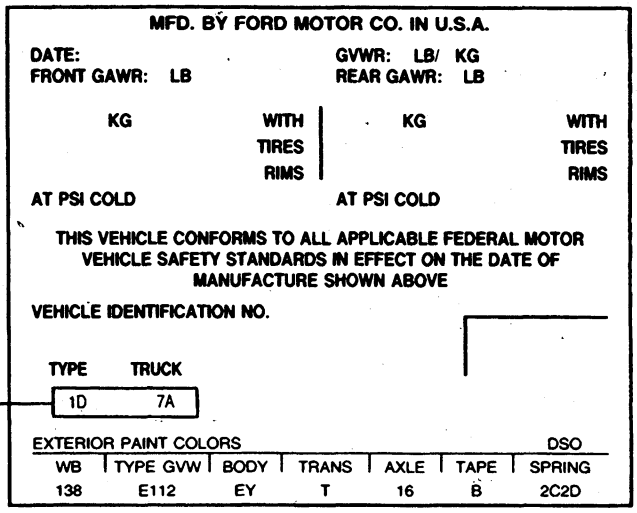
F-150 — F-350 AND F-SUPER DUTY EXTERIOR PAINT COLOR CODES

Code	Color
1C	Black
1D	Smoke Metallic
1G	Light Smoke Metallic
2D	Medium Scarlet
2H	Medium Cabernet
7H	Bright Regatta Blue Metallic
7N	Dark Shadow Blue Metallic
9M	White
9N	Desert Tan Metallic
9T	Light Chestnut
42	Alpine Green Metallic
95	Dark Chestnut Metallic
99	Prime

CY2668-2F

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

EXTERIOR PAINT COLOR CODES
E-150 — E-250 — E-350



E-150 — E-350

Code	Color
1D	Smoke Metallic
1G	Light Smoke Metallic
3R	Medium Shadow Blue Metallic
7A	Spinnaker Blue
7N	Dark Shadow Blue Metallic
9M	White
9N	Desert Tan Metallic
9T	Light Chestnut
27	Medium Red
95	Dark Chestnut Metallic
99	Prime

NOTE: Two sets of codes indicate two-tone paint.

CY2794-2D

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

TYPE — GROSS VEHICLE WEIGHT (GVW) CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: GVWR:
FRONT GAWR: REAR GAWR:
WITH TIRES RIMS AT PSI COLD
WITH TIRES RIMS AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.

TYPE — TRUCK

7N 9M

EXTERIOR PAINT COLORS

WB	TYPE GVW	BODY	TRANS	AXLE	DSO TAPE	DSO SPRING
133	F252	LG4	F	342	B	2D29

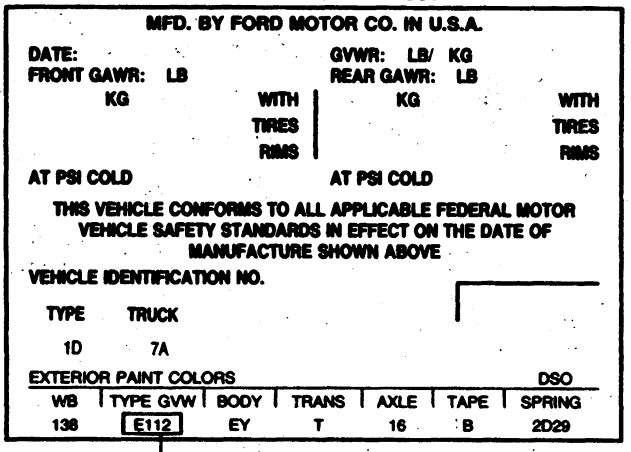
F25 2

Series	Series Code	GVWR Code	GVWR (lb.)	Wheelbase (in.)
Bronco				
U150	U15	2	6050	105
	U15	4	6300	105
	U15	5	6450	105
F-150 — F-250 — F-350				
F-150 (4x2)	F15	3	5250	117
	F15	4	5450	133
	F15	5	6250	133
	X15	1	6050	139
	X15	2	6250	155
F-150 (4x4)	F14	1	6100	117
	F14	2	6250	133
	X14	3	6250	139
	X14	1	6250	155
F-250 (4x2) Light Duty	F25	1	6600	133
	F25	2	7700	133
F-250 (4x2) Heavy Duty	F25	7	8600	133
	X25	9	8800	155
F-250 (4x4)	F26	1	6800	133
	X26	8	8800	155
	F26	8	8600	133
F-350 (4x2)	F35	2	10,000	133
	F37	4	8800	133
	F37	8	10,000	137, 161
	F37	9	11,000	137, 161
	W35	2	9200	168
	W35	3	10,000	168
	X35	1	10,000	155
F-350 (4x4)	F36	1	9000	133
	F38	2	8800	133
	F38	4	11,000	137, 161
	W36	1	9200	168
F-Super Duty (4x2)	F47	6	14,500	137, 161
F-Super Duty Stripped Chassis	F59	1	16,000	158
F-Super Duty Motor Home Chassis	F53	1	16,000	178, 208

CY2668-2F

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

TYPE — GROSS VEHICLE WEIGHT (GVW) CODES
E-150 — E-250 — E-350



E-150 — E-350 CLUB — XL AND XLT WAGONS

Series	Series Code	GVWR Code	GVWR (lb.)
E-150 Conventional	E11	2	6,600
E-250 Conventional	E21	P	8,550
E-350 Super	S31	5	9,100

E-150 — E-350 CARGO VANS

Series	Series Code	GVWR Code	GVWR (lb.)
E-150 Conventional Cargo	E14	1	5,500
	E14	2	6,100
	E14	3	6,500
E-150 Super Cargo	S14	1	6,200
E-250 Conventional Cargo	E24	1	7,200
	E24	2	7,900
E-250 Super Cargo	S24	1	8,100
E-350 Conventional Cargo	E34	1	9,400
	E34	2	9,500
E-350 Super Cargo	S34	1	9,000

E-350 REGULAR CUTAWAY VANS

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Regular Cutaway Van	E30	2	10,500 DR
	E30	3	11,000 DR

SR: Single Rear Wheels
DR: Dual Rear Wheels

E-350 COMMERCIAL CUTAWAY VANS

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Commercial Cutaway Van	E37	1	10,000 DR
	E37	2	10,300 DR
	E37	3	10,700 DR

SR: Single Rear Wheels
DR: Dual Rear Wheels

E-350 STRIPPED CHASSIS VAN

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Stripped Chassis Van	E39	U	9,400 SR
	E39	W	10,000 DR

SR: Single Rear Wheels
DR: Dual Rear Wheels

E-350 COMMERCIAL CUTAWAY STRIPPED CHASSIS

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Commercial Cutaway Stripped Chassis	E33	3	11,500 DR

CY2779-2E

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

BODY CODES
BRONCO, LIGHT TRUCK,
(F-150 — F-250 — F-350 — F-SUPER DUTY)

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: GVWR:
FRONT GAWR: REAR GAWR:

	WITH TIRES RIMS	WITH TIRES RIMS
AT PSI COLD	AT PSI COLD	

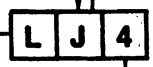
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.

TYPE — TRUCK
1D 7A

EXTERIOR PAINT COLORS DSO

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	SPRING
133	F252	LG4	F	342	B	2D29



LIGHT TRUCK

Code	Fabric	Seat Type
B	Vinyl	Bench
D	Knit & Vinyl	Bench
L	Bodycloth	Bench
R	Cloth	Captains Chair
S	Cloth	Bench
T	Bodycloth	Flight Bench

BRONCO

Code	Fabric	Seat Type
A	Vinyl	Bucket
L	Cloth	Bench
M	Cloth	Bucket
H	Bodycloth	Captains Chair
R	Cloth	Captains Chair

BRONCO AND F-SERIES

Trim Color	
Code	Color
B	Regatta Blue
D	Canyon Red
J	Granite
K	Chestnut

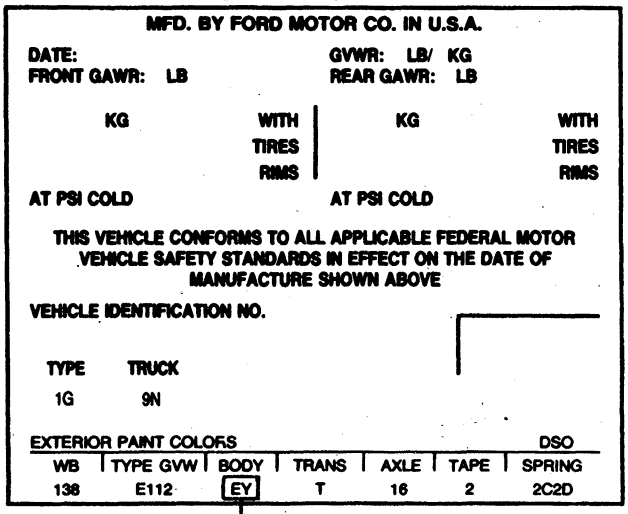
F-SERIES ONLY
CAB/BACK OF CAB

Super Cab	Crew Cab	Regular	Specifications
M	D	4 8 X	Styleside Pickup Chassis Cab Stripped Chassis (Mexico)

CY2388-2H

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

BODY CODES
E-150 — E-250 — E-350



SEAT TRIM AND STYLE

Code	Trim	Type
A	Vinyl	Bucket
E	Vinyl	Bucket
K	Cloth	Bucket
L	Cloth	Captain Chairs

TRIM COLOR

Code	Color
B	Regatta Blue
D	Canyon Red
J	Granite
K	Chestnut

CY2780-2E

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

TRANSMISSION CODES
BRONCO, E-150 — E-250 — E-350, F-150 — F-250 — F-350 — F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: GVWR:
FRONT GAWR: REAR GAWR:

WITH TIRES RIMS	WITH TIRES RIMS
AT PSI COLD	AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.

TYPE — TRUCK
7N 9M

EXTERIOR PAINT COLORS

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
133	F252	LG4	F	342	B	2D29

Code	Description
BRONCO	
K	Automatic C6
T	Automatic — AOD
M	Manual — 5-Speed Overdrive (M5OD)
Z	Manual — 5-Speed H.D. Overdrive (M5OD-HD)
F	Manual — 4-Speed

E-150 — E-250 — E-350	
G	Automatic — C6
T	Automatic 4-Speed AOD
E	Automatic — E4OD
M	Manual — 5-Speed Overdrive (M5OD)
Z	Manual — 5-Speed H.D. Overdrive (M5OD-HD)

F-150 — F-250 — F-350	
K	Automatic — C6
T	Automatic — AOD
E	Automatic — E4OD
F	Manual — 4-Speed
C	Manual — 5-Speed Close Ratio
M	Manual — 5-Speed Overdrive (M5OD)
Z	Manual — 5-Speed H.D. Overdrive (M5OD-HD)

CY2390-2H

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

AXLE CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: GVWR:
FRONT GAWR: REAR GAWR:

WITH TIRES RIMS AT PSI COLD — WITH TIRES RIMS AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.

TYPE-TRUCK
7N 9M

EXTERIOR PAINT COLORS

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
133	F252	LG4	F	252	B	2D29

25 | 2

REAR AXLE CODES

Code	Capacity (lbs.)	Ratio
12	3800	2.73
18	3800	3.08
19	3800	3.55
H5	3800	4.10
H8	3800	3.08
H9	3800	3.55
25	3800	4.10
27	5300	3.73
29	5300	3.55
B5	5300	4.10
B9	5300	3.55
35	6250	4.10
39	6250	3.55
C5	6250	4.10
C9	6250	3.55
45	7400	4.10
49	7400	3.55
D5	7400	4.10
65	8250	4.10
69	8250	3.55
F5	8250	4.10
72	11,000	4.63
73	11,000	5.13
W5	8250	4.00

FRONT AXLE CODES (Not Applicable On E-150 — E-250 — E-350)

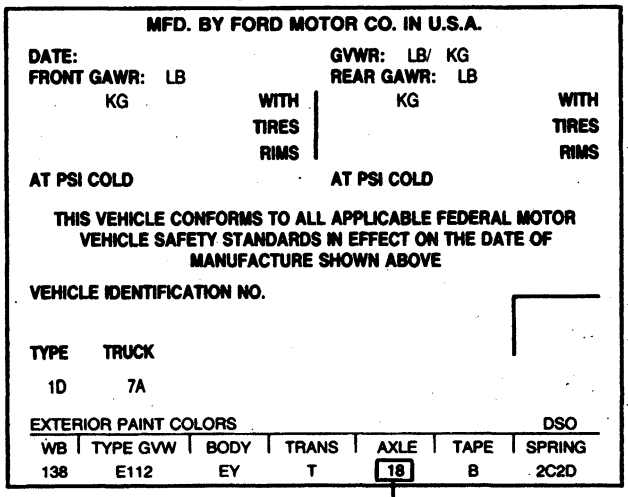
Bronco and F-150 — F-250 — F-350

Code	Description
2	Front Axle Limited Slip

CY2671-2F

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

AXLE CODES
E-150 — E-250 — E-350



E-150 — E-250 — E-350 REGULAR REAR AXLE

Code	# Capacity	Ratio
18	3800	3.08
19	3800	3.55
23	5300	3.54
24	5300	3.73
33	6340	3.54
52	7400	4.10
53	7400	3.54
32	6340	4.10

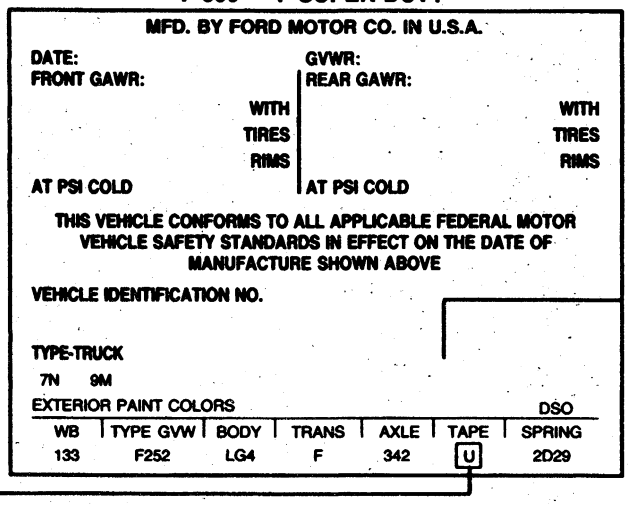
E-150 — E-250 — E-350 LIMITED SLIP REAR AXLE

Code	# Capacity	Ratio
H9	3750	3.08
B4	5300	3.73
C2	6340	4.10
C3	6340	3.54
E2	7400	4.10

CY2781-2D

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

EXTERNAL BODY TAPE STRIPE CODES
BRONCO, E-150 — E-250 — E-350, F-150 — F-250 — F-350 — F-SUPER DUTY



BRONCO EXTERNAL TUTONE BODY TAPE STRIPE CODES

Code	Tape Stripe
1	Light Regatta Blue/Bright Regatta Blue
2	Light Chestnut Tan/Light Desert Tan
3	Medium Charcoal/Red Orange
U	Light Desert Tan — Paint Stripe with Medium Tan/Dark Tan — Tape Break Stripe

F-150 — F-350 ALL TUTONES (TAPE)
REGULAR AND VICTORIA TUTONES (TAPE)

Code	Tape Stripe
1	Light Regatta Blue/Bright Regatta Blue
2	Light Chestnut/Light Desert Tan
3	Medium Charcoal/Red Orange

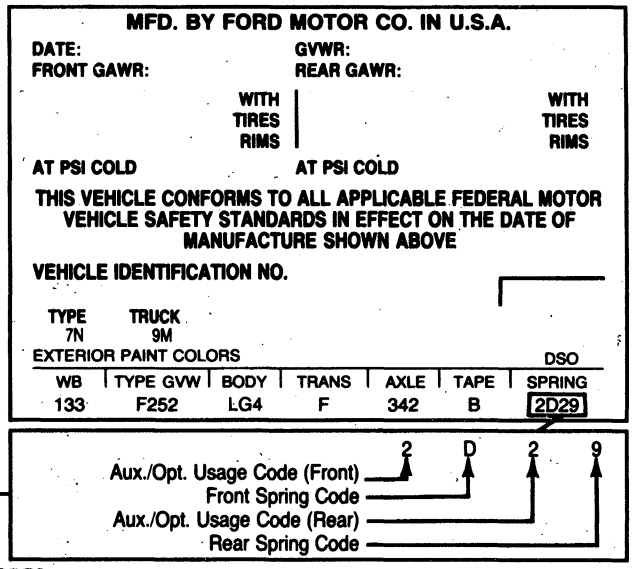
F-150 — F-350 EXTERNAL BODY TAPE STRIPE CODES
XL SRW STYLESIDE SOLID PAINT (PAINT STRIPE)
LESS CHAMFER STRIPES

Code	Tape Stripe
1	Red Orange
2	Grabber Blue
3	Copper
4	Light Desert Tan
5	Medium Gray

CY2672-2F

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

SUSPENSION — SPRING IDENTIFICATION CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY



BRONCO SPRING IDENTIFICATION CODES

Aux./Opt. Usage Code (Front) — Not Applicable **Aux./Opt. Usage Code (Rear) — Not Applicable**

FRONT SPRING CODES — BRONCO

Code	Part Number
B	E0TA-5310-BC
C	E0TA-5310-CC
G	E0TA-5310-GC
U	E0TA-5310-UC
V	E0TA-5310-VB

REAR SPRING CODES — BRONCO

Code	Part Number
Z	E3TA-5560-ANA

F-150 — F-250 — F-350 — F-SUPER DUTY AUX./OPT. FRONT SPRING USAGE CODE

Code	Description
3	Maximum Front GAWR Package
4	Heavy Duty Front Suspension Package

F-150 — F-250 — F-350 — F-SUPER DUTY FRONT SPRING CODES

Code	Part Number
A	E0TA-5310-AC
B	E0TA-5310-BC
C	E0TA-5310-CC
D	E0TA-5310-DC
E	E0TA-5310-EC
F	E0TA-5310-FC
G	E0TA-5310-GC
H	E3TA-5310-XA
J	E3TA-5310-YA
K	E3TA-5310-ZA
M	E3TA-5310-AAA
N	E5TS-5310-BA
R	E5TA-5310-RA
S	E5TA-5310-SA
T	E5TA-5310-TA
U	E0TA-5310-UC
V	E0TA-5310-VB
1	E8TA-5310-AA
2	E9TD-5310-BB
3	E9TD-5310-AD
5	E0TA-5310-AAB
6	E0TA-5310-ABB
7	E0TA-5310-ACB
8	E5TA-5310-NA
9	E3TA-5310-ABA

F-150 — F-250 — F-350 — F-SUPER DUTY AUX./OPT. REAR SPRING USAGE CODE

Code	Description
3	Heavy Duty Rear Suspension Package
—	Auxiliary Rear Springs
4	400# — F-150
7	710# — F-250 — F-350
9	900# — F-350 — F-Super Duty
X	F53 — F59

F-150 — F-250 — F-350 — F-SUPER DUTY REAR SPRING CODE

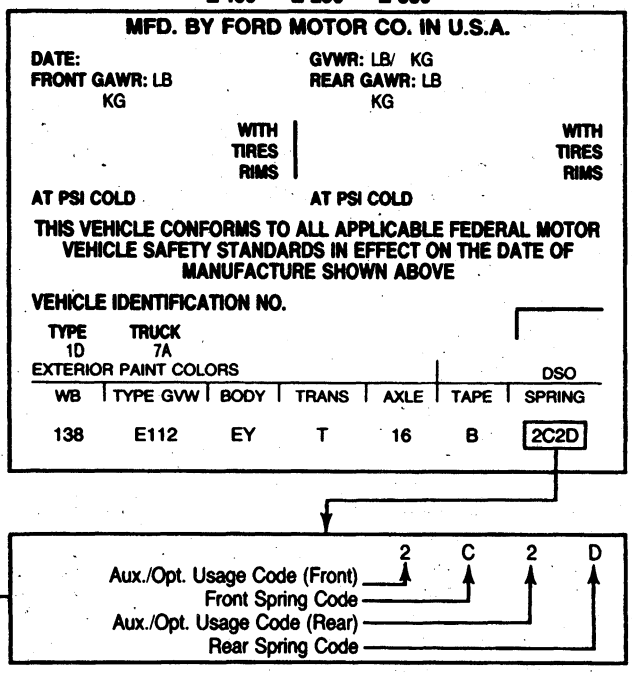
Code	Part Number
A	E4TA-5560-SA
D	E6TA-5560-NA
F	E7TA-5560-FA
L	E3TA-5560-KA
V	E6TA-5560-RA
Y	E7TA-5560-YA
2	E9TD-5560-BD
3	E9TD-5560-CA
4	E9TD-5560-AD
6	E4TA-5560-EA
7	E7TA-5560-KA
8	E8TA-5A975-AA
9	E4TA-5560-HA

CY2673-2E

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

SUSPENSION — SPRING IDENTIFICATION CODES
E-150 — E-250 — E-350

SUSPENSION-SPRING IDENTIFICATION CODES
E-150 — E-250 — E-350



E-150 — E-250 — E350
AUX./OPT. FRONT SPRING USAGE CODE

Code	Description
2	Heavy Duty Front Springs
4	Front Spring 3,850/4,200 # GAWR Rating

E-150 — E-250 — E350
FRONT SPRING CODES

Code	Part Number
F	D5UA-5310-HB
G	D5UA-5310-JB
H	D5UA-5310-KA
J	D5UA-5310-LB
K	D5UA-5310-MA
L	D5UA-5310-RA
M	D5UA-5310-SA
N	D5UA-5310-UA
O	D5UA-5310-VA
P	D5UA-5310-ALB
R	D5UA-5310-AMB
S	D5UA-5310-ARB
T	D5UA-5310-AUB
Y	D8TA-5310-HA
1	E7UA-XA
2	E7UA-YA
3	E7UA-ZA
4	E7UA-AAA
5	E7UA-BAA
6	E7UA-CAA
7	E7UA-DAA
X	E6US-AA

E-150 — E-250 — E-350
AUX./OPT. REAR SPRING USAGE CODES

Code	Description
2	Heavy Duty Rear Springs
4	Handling Package

E-150 — E-250 — E-350
REAR SPRING CODES

Code	Part Number
A	D9TA-5560-ZA
C	E1TA-5560-ACA
F	E1TA-5560-ALA
J	D9TA-5560-LA
K	D9TA-5560-HA
L	E2TA-5560-ARA
M	E1TA-5560-AGA
N	E1TA-5560-AHA
P	D9TA-5560-AYA
Q	E0TA-5560-BVA
T	D9TA-5560-KA
W	E4UA-5560-RA
Y	D9TA-5560-AVA
Z	D9TA-5560-JA

CY2782-2E

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

DISTRICT SALES OFFICE (DSO) AND WHEELBASE (WB) CODES BRONCO, E-150 — E-250 — E-350, F-150 — F-250 — F-350 — F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: GVWR:
FRONT GAWR: REAR GAWR:
WITH TIRES RIMS AT PSI COLD
WITH TIRES RIMS AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.

TYPE-TRUCK
7N 9M

EXTERIOR PAINT COLORS

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
133	F252	LG4	F	342	B	2D29

DSO — FSO — PTO (DOMESTIC, FOREIGN AND SPECIAL ORDER)

The D.S.O. space will show a two-digit code number of the district which ordered the unit (see chart below). This code will appear on all units — domestic or export. If unit is built on a D.S.O., F.S.O., P.T.O. (special orders), the complete order number is under the D.S.O. spacer **after** the district code number.

Wheelbase (inches)		
Bronco		
105		
F-150 — F-250 — F-350		**F-Super Duty**
117		137
133	155	161
137	161	158
139	168	178
		208
E-150 — E-250 — E-350 (Econoline and Club Wagon)		
124		
138		
158		
176		

Code	District
11	Boston
12	Buffalo
13	New York
14	Pittsburgh
16	Philadelphia
17	Washington
21	Atlanta
22	Charlotte
23	Memphis
24	Jacksonville
26	New Orleans
28	Louisville
41	Chicago
42	Cleveland
43	Milwaukee
46	Indianapolis
47	Cincinnati
48	Detroit

Code	District
52	Dallas
53	Kansas City
54	Omaha
55	St. Louis
57	Houston
58	Twin Cities
71	Los Angeles
72	San Jose
74	Seattle
75	Phoenix
76	Denver
83	Government
84	Home Office Reserve
85	American Red Cross
86	Recreation Vehicles
87	Body Company
89	Transportation Services
90's	Export
00	Special

Ford of Canada	
Mercury Regions	**Ford Regions**
A1 Central	B1 Central
A2 Eastern	B2 Eastern
A3 Atlantic	B3 Atlantic
A4 Midwestern	B4 Midwestern
A6 Western	B6 Western
A7 Pacific	B7 Pacific
A8 Great Lakes	B8 Great Lakes
11 Export	11 Export

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SECTION 10-02 Maintenance

SUBJECT	PAGE	SUBJECT	PAGE
MAINTENANCE		VEHICLE APPLICATION	10-02-1
Scheduled Maintenance Emissions	10-02-1		

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 and F-Super Duty, and Bronco Vehicles.

MAINTENANCE

The scheduled and non-scheduled maintenance recommendations are included in this Section for reference. The emission systems scheduled maintenance services and the vehicle maintenance services are separated. Be sure to perform all maintenance services by referring to both Sections of the schedule.

It should be noted, however, that any modification of the emission control systems could create liability under Federal Law (U.S.) if made prior the first sale and registration and, under the laws of some states, if made thereafter. Further, federal law prohibits vehicle manufacturers or dealers and other persons engaged in the business of repairing, servicing, selling, leasing, or trading motor vehicles as well as fleet operations from knowingly removing or rendering an emission control system inoperative after sale and delivery to an ultimate purchaser. In Canada, modifications of the emission control system could create liability under applicable Federal or Provincial laws.

Scheduled Maintenance Emissions

An Emission Systems Required Maintenance Chart for each truck model is listed on the following pages.

The Emission Systems Required Maintenance Chart lists the items required to maintain the vehicle emission systems at levels determined by the Federal Government (Environmental Protection Agency). Refer to the appropriate Sections of the Engine Shop Manual and the Engine/Emission Diagnosis Manual* for the Maintenance Procedures, which are related to the items listed on the maintenance schedule. Use these procedures to perform the required emission system maintenance items listed on the maintenance charts.

Maintenance service adjustments must conform to specifications contained in the Engine/Emissions Diagnosis Manual*, to those listed in the Truck Performance Specifications issue of the Technical Service Bulletin or shown on the Vehicle Emission Control Information Decal which is located on or near the engine, or the emission systems may become inoperative.

If an engine is equipped with a "Dura-Spark" ignition system and any high tension ignition wire was detached from a spark plug, the distributor cap, or the coil to perform a maintenance operation, Silicone Dielectric Compound [WA-10, D7AZ-19A331-A (ESA-M1C171-A) or equivalent] must be applied to the boot before reconnection. Using a small clean screwdriver, apply a thin layer of Silicone Dielectric Compound on the entire interior surface of the boot.

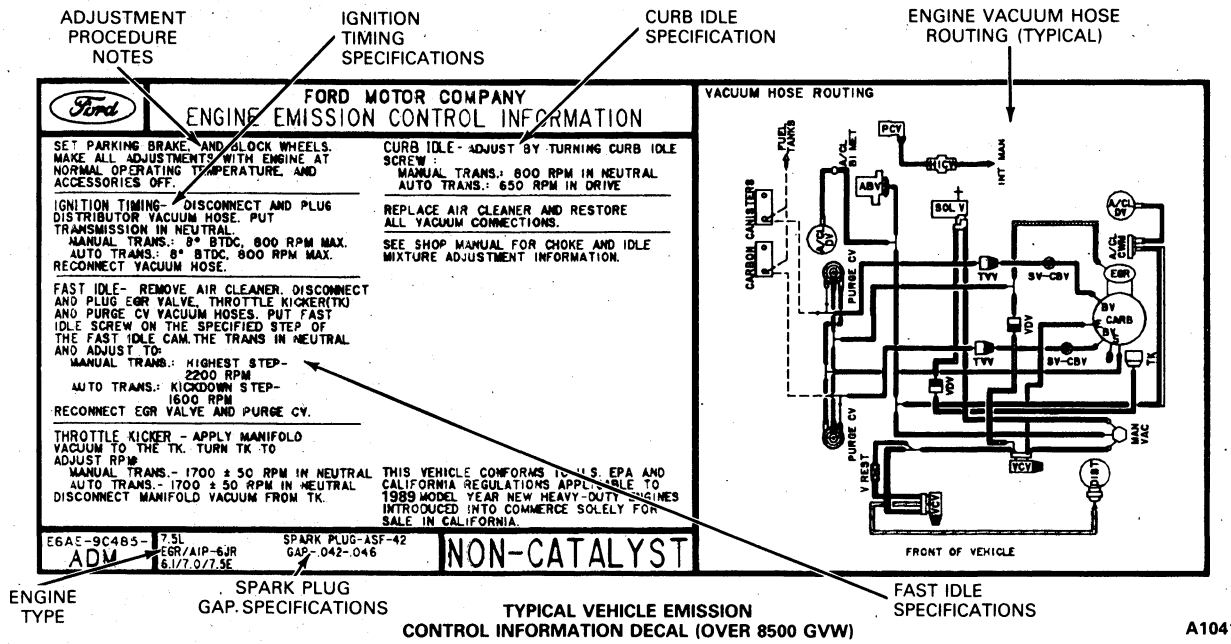
As a safety precaution, before starting the engine to perform maintenance, make sure the transmission selector is in Park (Automatic Transmission) or Neutral (Manual Transmission), the parking brake set and the wheels blocked.

*Can be purchased as a separate item.

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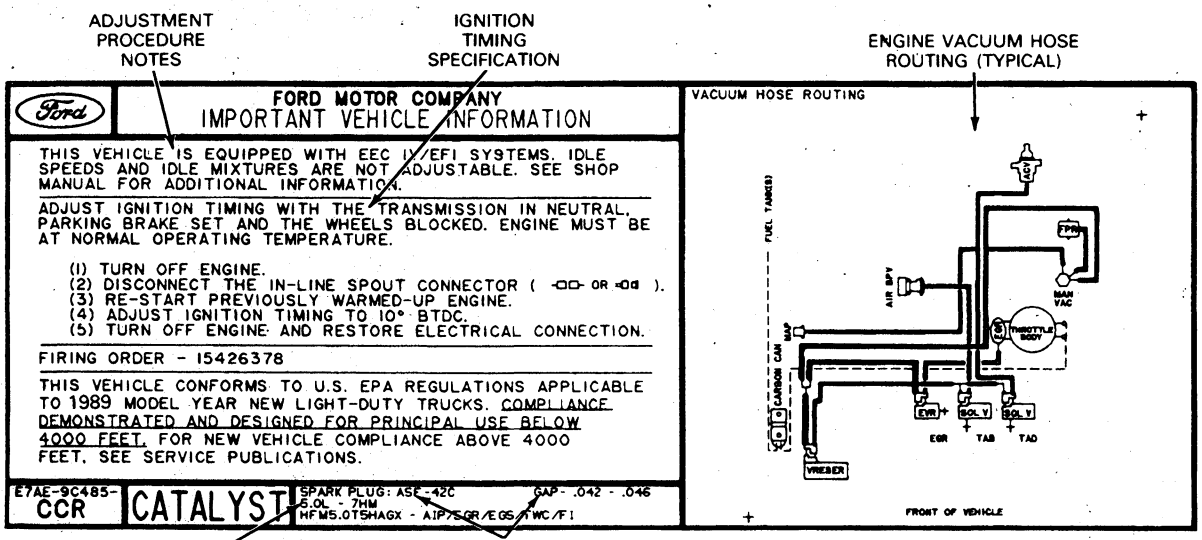
MAINTENANCE (Continued)

TO ASSURE THE DURABILITY OF YOUR VEHICLE AND ITS EMISSION CONTROL SYSTEMS IT IS NECESSARY THAT SCHEDULED MAINTENANCE BE PERFORMED AT THE DESIGNATED INTERVALS. FORD RECOMMENDS THE USE OF GENUINE FORD REPLACEMENT PARTS. YOU MAY, HOWEVER, ELECT TO HAVE MAINTENANCE, REPLACEMENT, OR REPAIR OF THE EMISSIONS CONTROL DEVICES AND SYSTEMS (THE COST OF WHICH IS NOT COVERED BY WARRANTY) PERFORMED BY ANY AUTOMOTIVE REPAIR ESTABLISHMENT OR INDIVIDUAL AND MAY ELECT TO USE OTHER THAN FORD SERVICE PARTS FOR SUCH MAINTENANCE OR REPAIR. IF OTHER THAN FORD OR MOTORCRAFT PARTS OR FORD AUTHORIZED, REMANUFACTURED PARTS ARE USED FOR MAINTENANCE REPLACEMENTS OR FOR THE SERVICE OF COMPONENTS AFFECTING EMISSIONS CONTROL. THE OWNER SHOULD ASSURE HIMSELF THAT SUCH PARTS ARE WARRANTED BY THEIR MANUFACTURER TO BE EQUIVALENT TO GENUINE FORD MOTOR COMPANY PARTS IN PERFORMANCE AND DURABILITY. PLEASE CONSULT YOUR WARRANTY BOOKLET FOR COMPLETE WARRANTY INFORMATION.



TYPICAL VEHICLE EMISSION CONTROL INFORMATION DECAL (OVER 8500 GVW)

A10417-2B



TYPICAL VEHICLE EMISSION CONTROL INFORMATION DECAL (UNDER 8500 GVW)

A10418-2B

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MAINTENANCE (Continued)

Maintenance Schedule Applicable To Bronco, E-150, E-250, E-350 and F-150, F-250, F-350, F-Super Duty Trucks

Two maintenance schedules are specified for the 1989 model Bronco, Econoline and F-Series trucks. They are identified by the letters B, and G. The application of the various maintenance schedules are as follows:

Catalyst Equipped Vehicles Require Unleaded Fuel Only

Maintenance Schedule "B"—Gasoline Engine Equipped Vehicles with Light Duty Emissions (Under 8500 Pounds GVW)

The following catalyst equipped vehicles, designated for use with "Unleaded Fuel Only" should be maintained according to Maintenance Schedule "B."

- F-150
- E-150/E-250 and Club Wagon
- Bronco

Catalyst Equipped Vehicles Require Unleaded Fuel Only

Maintenance Schedule G—Gasoline Engine Equipped Vehicles with Heavy Duty Emissions (Over 8500 Pounds GVW)

The "G" maintenance schedule is used for the following unleaded fuel vehicles with 4.9L 5.8L and 7.5L EFI engines.

- F-150/F-250/F-350
- F-Super Duty
- E-250/E-350 and Club Wagon

Maintenance Schedule "E"—7.3L Diesel Engine Equipped Vehicles

The "E" maintenance schedule is used for the following Diesel Engine Equipped Vehicles:

- Heavy Duty F-250
- F-350
- F-Super Duty
- Heavy Duty E-250
- E-350

REQUIRED MAINTENANCE SERVICE PROCEDURES

Refer to the appropriate Sections of the Engine Shop Manual and the Engine/Emission Diagnosis* manual for the required maintenance service procedures.

*Can be purchased as a separate item.

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MAINTENANCE (Continued)

MAINTENANCE SCHEDULE B — NORMAL DRIVING CONDITIONS

F-150/250 and Bronco Unleaded Fuel Vehicles with Light Duty Emissions (Under 8,500 lbs. GVWR)

B — Required for all vehicles.

b — Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

NORMAL DRIVING SERVICE INTERVALS — PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST.																	
MAINTENANCE OPERATION	MILES (Thousands)	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120
	KILOMETERS (Thousands)	12	24	36	48	60	72	84	96	108	120	132	144	156	168	181	193
Emission Control Systems																	
Change Engine Oil and Oil Filter — every 6 months OR		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	b
Replace Spark Plugs					B				b				b				b
Replace Engine Coolant — every 36 months OR					B				B				B				b
Check Engine Coolant Condition and Protection, Hoses and Clamps Annually — Prior to Cold Weather		ANNUALLY															
Replace Air Cleaner Filter					B				b				b				b
Replace Crankcase Emission Filter					B				b				b				b
Clean Idle Speed Control Air Bypass Control Valve (4.9L, 5.0L)									b								b
Replace PCV Valve									b/1								b
Replace Ignition Wires									b								b
Check Thermactor Hoses and Clamps#									b								b
Other Systems																	
Inspect Drive Belt Condition and Tension					B				B								
Check Wheel Lug Nut Torque*		B	B	B	B	B	B	B	B								
Check Clutch Reservoir Fluid Level		B	B	B	B	B	B	B	B								
Lubricate Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins			B		B		B		B								
Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank System)		B	B	B	B	B	B	B	B	Beyond 60,000 miles/96 000 km continue recommended maintenance operations at intervals indicated for 0-60,000 miles/96 000 km							
Inspect and Lubricate Front Wheel Bearings					B				B								
Rotate Tires		B	B		B		B		B								
Inspect Disc Brake System					B				B								
Inspect Drum Brake Systems, Hoses, and Lines					B				B								
Inspect Exhaust System for Leaks, Damage or Loose Parts					B				B								
Inspect Parking Brake System for Damage and Operation					B				B								
Lubricate Throttle Ball Stud					B				B								
Lubricate Steering Linkage, Driveshaft U-Joints, and Slip Yoke if equipped with Grease Fittings		B	B	B	B	B	B	B	B								
Lubricate Caliper Slide Rails			B		B		B		B								
Lubricate Front Axle R.H. Axle Shaft Slip Yoke (4x4)					B				B								
Lubricate Front Axle Spindle Pins (F-350 4x4)		B	B	B	B	B	B	B	B								
Inspect Spindle Needle Bearing Lubrication (4x4)					B				B								
Inspect Hub Lock Lubrication (4x4)					B				B								
Change Transfer Case Oil (4x4)									B								
Change Manual Transmission Oil (HD M50D/S5-42 and Warner T18)									B								

Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

* Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles equipped for snowplowing). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

/1 At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles.

UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery use.
- Snow plowing.
- High speed operation with a fully loaded vehicle (Max. GVW).

Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

Check/regap spark plugs every 15,000 miles (24 000 km).

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

— If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC/HD MANUAL 5-SPEED (S5-42) TRANSMISSION FLUID — Change each 30,000 miles (48 000 km) — if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.
- Operating a transmission mounted PTO.

EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Lubricate automatic transmission external controls (Bellcrank system).
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts.
- Lubricate clutch release lever pivot (7.3L and 7.5L).

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MAINTENANCE (Continued)

MAINTENANCE SCHEDULE G — NORMAL DRIVING CONDITIONS

F-150/350 and Super Duty Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L EFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G — Required for all vehicles

g — Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

NORMAL DRIVING SERVICE INTERVALS — PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST.

MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	177	184	193
Emission Control Systems																									
Change Engine Oil and Oil Filter — every 6 months OR		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Replace Spark Plugs							G						g						g						g
Replace Engine Coolant — every 36 months OR							G						G						G						g
Check Engine Coolant Condition and Protection, Hoses and Clamps Annually — Prior to Cold Weather		ANNUALLY																							
Replace Air Cleaner Filter							G						g						g						g
Replace Crankcase Emission Filter							G						g						g						g
Replace PCV Valve													g/1												g
Replace Ignition Wires													g												g
Check Thermactor Hoses and Clamps#													g												g
Clean Idle Speed Control Air Bypass Valve													g												g
Other Systems																									
Inspect Drive Belt Condition and Tension				G			G			G			G	Beyond 60,000 miles/96 000 km continue recommended maintenance operations at intervals indicated for 0-60,000 miles/96 000 km												
Check Wheel Lug Nut Torque*		G	G	G	G	G	G	G	G	G	G	G	G												
Check and Lubricate Clutch Release Lever (7.5L)		G	G	G	G	G	G	G	G	G	G	G													
Check Clutch Fluid Reservoir Level		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins				G			G			G			G											
Lubricate Automatic Transmission Linkage (Bellcrank System)		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Front Axle Spindle Pins, Steering Linkage, Driveshaft U-Joints and Slip Yoke if Equipped with Fittings		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Front Axle Spindle Pins (F-Super Duty)				G			G			G			G												
Rotate Tires		G		G			G			G			G												
Inspect Disc Brake System, Lube Caliper Slide Rails				G			G			G			G												
Inspect Drum Brake System, Hoses and Lines							G						G												
Inspect and Lubricate Front Wheel Bearings							G						G												
Inspect Exhaust System for Leaks, Damage or Loose Parts							G						G												
Inspect Parking Brake System for Damage and Operation							G						G												
Inspect Parking Brake Fluid Level (F-Super Duty)							G						G												
Lubricate Throttle Ball Stud							G						G												
Lubricate Front Drive Axle R.H. Axle Slip Yoke (4x4)							G						G												
Inspect Spindle Needle Bearing Lubrication (4x4)							G						G												
Inspect Hub Lock Lubrication (4x4)							G						G												
Change Transfer Case Oil (4x4)													G												
Change Manual Transmission Oil (HD M50D/S5-42)													G												

Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

* Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation. See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

/1 At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles.

UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery use.
- Snow plowing.
- High speed operation with a fully loaded vehicle (Max. GVW).

Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

Check/Regap Spark Plugs every 15,000 miles (24 000 km).

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

— If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC/HD MANUAL 5-SPEED (S5-42) TRANSMISSION FLUID — Change each 30,000 miles (48 000 km) — if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.
- Operating a transmission mounted PTO.

EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Lubricate automatic transmission external controls (Bellcrank system).
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts.
- Lubricate clutch release lever pivot (7.3L and 7.5L).

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MAINTENANCE (Continued)

MAINTENANCE SCHEDULE B — NORMAL DRIVING CONDITIONS

E-150/250 and Club Wagon Unleaded Fuel Vehicles with Light Duty Emissions (Under 8,500 lbs. GVWR)

B — Required for all vehicles.

b — Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

NORMAL DRIVING SERVICE INTERVALS — PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST																
MAINTENANCE OPERATION	MILES (Thousands)	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120
	KILOMETERS (Thousands)	12	24	36	48	60	72	84	96	108	120	132	144	156	168	181	193
Emission Control Systems																	
Change Engine Oil and Oil Filter — every 6 months OR		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	b
Replace Spark Plugs					B				b				b				b
Replace Engine Coolant — every 36 months OR					B				B				B				b
Check Cooling System, Hoses and Clamps — Prior to Cold Weather		ANNUALLY															
Replace Air Cleaner Filter					B				b				b				b
Replace Crankcase Emission Filter					B				b				b				b
Clean Idle Speed Control Air Bypass Control Valve (4.9L, 5.0L)									b								b
Replace PCV Valve									b/1								b
Replace Ignition Wires									b								b
Check Thermactor Hoses and Clamps (4.9L, 5.0L, 5.8L)#									b								b
Other Systems																	
Inspect Drive Belt Condition and Tension					B				B								
Check Wheel Lug Nut Torque★		B	B	B	B	B	B	B	B								
Rotate Tires		B	B		B		B		B								
Check Clutch Reservoir Fluid Level		B	B	B	B	B	B	B	B								
Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank System)		B	B	B	B	B	B	B	B	Beyond 60,000 miles/96 000 km, continue recommended maintenance operations at intervals indicated for 0-60,000 miles/96 000 km.							
Inspect and Lubricate Front Wheel Bearings					B				B								
Inspect Disc Brake System					B				B								
Inspect Drum Brake Systems, Hoses, and Lines					B				B								
Inspect Exhaust System for Leaks, Damage or Loose Parts					B				B								
Inspect Parking Brake System for Damage and Operation					B				B								
Lubricate Throttle Ball Stud					B				B								
Lubricate Steering Linkage, Driveshaft U-Joints, and Slip Yoke if Equipped with Grease Fittings		B	B	B	B	B	B	B	B								
Lubricate Caliper Slide Rails			B		B		B		B								
Lubricate Front Axle R.H. Axle Shaft Slip Yoke (4x4)					B				B								

Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

★ Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation. See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

/1 At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles.

UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery service.
- High speed operation with a fully loaded vehicle (max. GVW).

Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

Check/regap SPARK PLUGS every 15,000 miles (24 000 km).

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

— If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC TRANSMISSION FLUID — Change each 30,000 miles (48 000 km) — if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.

EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Lubricate automatic transmission external controls (Bellcrank system).
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts.
- Lubricate clutch release lever pivot (7.5L).

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MAINTENANCE (Continued)

MAINTENANCE SCHEDULE G — NORMAL DRIVING CONDITIONS

E-250/350 and Club Wagon Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L EFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G — Required for all vehicles

g — Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

NORMAL DRIVING SERVICE INTERVALS — PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST.																								
MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	177	184	193
Emission Control Systems																									
Change Engine Oil and Oil Filter — every 6 months OR		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Replace Spark Plugs							G						g						g						g
Replace Engine Coolant — every 36 months OR							G						G						G						g
Check Engine Coolant Condition and Protection, Hoses and Clamps Annually — Prior to Cold Weather		ANNUALLY																							
Replace Air Cleaner Filter							G						g						g						g
Replace Crankcase Emission Filter							G						g						g						g
Replace PCV Valve													g/1												g
Replace Ignition Wires													g												g
Check Thermactor Hoses and Clamps#													g												g
Clean Idle Speed Control Air Bypass Valve													g												g
Other Systems																									
Inspect Drive Belt Condition and Tension							G						G	Beyond 60,000 miles/96 000 km continue recommended maintenance operations at intervals indicated for 0-60,000 miles/96 000 km												
Check Wheel Lug Nut Torque*		G	G	G	G	G	G	G	G	G	G	G	G												
Rotate Tires		G		G			G			G			G												
Check Clutch Reservoir Fluid Level		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Automatic Transmission Linkage (Bellcrank System)		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Front Axle Spindle Pins, Steering Linkages, Driveshaft U-Joints and Slip Yoke if Equipped with Fittings		G	G	G	G	G	G	G	G	G	G	G	G												
Inspect Disc Brake System, Lube Caliper Slide Rails				G			G			G			G												
Inspect Drum Brake Systems, Hoses and Lines							G						G												
Inspect and Lubricate Front Wheel Bearings							G						G												
Inspect Exhaust System for Leaks, Damage or Loose Parts							G						G												
Inspect Engine Air Induction System (E-350 over 10,000 lbs. GVWR only)							G						G												
Inspect Fan and Fan Shroud (E-350 over 10,000 lbs. GVWR only)							G						G												
Inspect Parking Brake System for Damage and Operation							G						G												
Lubricate Throttle Ball Stud							G						G												
Change Manual Transmission Oil (HD M50D/S5-42)													G												

Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

* Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles equipped with dual rear wheels). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

/1 At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.8L and 7.5L engines except California and Canada vehicles.

UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery service.
- High speed operation with a fully loaded vehicle (Max. GVW).

Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

Check/regap spark plugs every 15,000 miles (24 000 km).

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS — If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC TRANSMISSION FLUID — Change each 30,000 miles (48 000 km) — if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Towing a trailer.
- Door-to-door delivery, police or taxi.

EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Lubricate automatic transmission external controls (Bellcrank system).
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts.
- Lubricate clutch release lever pivot (7.5L).

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MAINTENANCE (Continued)

MAINTENANCE SCHEDULE E — VEHICLES EQUIPPED WITH 7.3L DIESEL ENGINES

SERVICE INTERVALS — PERFORM AT THE MONTHS OR THE DISTANCES SHOWN, WHICHEVER COMES FIRST																								
MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	105	113	121	129	137	145	153	161	169	177	185	193
Emission Control Systems																									
Change Engine Oil and Replace Oil Filter — every 6 months or at Mileage①		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Check Engine Idle Speed (Adjust as Required) ④		X		X			X			X			X			X			X			X			X
Check Throttle Operation and Idle Return Spring ④		X		X			X			X			X			X			X			X			X
Inspect, Clean and Lubricate Face Cam of Fuel Injector Pump		X		X			X			X			X			X			X			X	X	X	X
Check Coolant Level in the Radiator and Overflow Bottle		MONTHLY																							
Check Coolant Condition and Protection, Cooling System/Hoses/Clamps (Prior to Cold Weather)		ANNUALLY																							
Replace Coolant Every 36 Months or at Mileage							X						X						X						X
Check and Inspect Drive Belt Condition and Tension②							X						X						X						X
Replace Air Cleaner Element②							X						X						X						X
Inspect Engine Air Induction System							X						X						X						X
Replace Fuel Filter②													X												
Drain Water from Fuel/Filter Bowl③		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Other Systems																									
Check and Adjust Wheel Lug Nut Torque*		X	X	X	X	X	X	X	X	X	X														
Inspect Exhaust System/Shields/Joints for Leaks, Breakage, Looseness, and Corrosive Damage							X						X												
Inspect Diesel Engine Mounted Noise Hardware for Damage or Oil/Fuel Saturation i.e.,; Block Panels, Oil Pan Covers, Treated Valve Covers							X						X												
Inspect the Vehicle for Missing, Damaged, or Mislocated Chassis and Body Mounted Noise Shields							X						X												
Inspect Fan and Fan Shroud (E- and F-350 Over 10,000 lbs. GVWR Only)				X			X			X			X												
Lubricate Driveshaft Slip Yoke and U-Joint if Equipped with Grease Fittings		X	X	X	X	X	X	X	X	X	X	X	X												
Lubricate Steering Linkage (Only if Equipped with Grease Fittings)		X	X	X	X	X	X	X	X	X	X	X	X												
Lubricate Front Axle Spindle Pins (Econoline Only)		X	X	X	X	X	X	X	X	X	X	X	X												
Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank System)①		X	X	X	X	X	X	X	X	X	X	X	X												
Change Automatic Transmission Fluid⑤							X						X												
Check Clutch Reservoir Fluid Level		X	X	X	X	X	X	X	X	X	X	X	X												
Lubricate Clutch Release Lever Pivots		X	X	X	X	X	X	X	X	X	X	X	X												
Check Brake Master Cylinder Fluid Level							X						X												
Inspect Disc Brake System and Lube Caliper Slide Rails				X			X			X			X												
Inspect Parking Brake System for Damage and Operation				X			X			X			X												
Inspect Drum Brake Linings, Lines, Hoses				X			X			X			X												
Rotate Tires		X		X			X			X			X												
Lubricate Throttle Ball Stud							X						X												
Inspect and Lubricate Front Wheel Bearings							X						X												
Inspect Hub Lock Lubrication (4x4)							X						X												
Inspect (4x4) Spindle Needle Bearing Lubrication							X						X												
Change Transfer Case Oil (4x4)													X												X

NOTE: Checks, Inspections and Lubrication Intervals on Non-Emission Items (Other Systems) Should Be Continued at the Same Mileage Intervals

*Wheel lug nuts must be retightened to proper torque specification at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles with dual rear wheels or vehicles equipped for snowplowing). See your Owner Guide for proper torque specification. Also retighten to proper torque specification at 500 miles/800 km, after any wheel change, or any other time the wheel lug nuts have been loosened.

①SEVERE SERVICE OPERATION
When operating your vehicle under any of the following conditions, change engine oil and filter every three months or 2500 miles (4 000 km) whichever occurs first. Use an engine oil conforming to Ford Specifications or the equivalent oil conforming to API service categories of *both SF* and *CD*. Do not use oil labeled as *only SF* or *only CD*, as they could cause engine damage. The oil should be of the proper viscosity (thickness) as identified on page 29.

- Sustained high speed driving at GVWR during hot weather (over 90°F/32°C).
- Operation in severe dust conditions.
- Trailer towing for long distances (over 1,000 miles/1 600 km).
- Frequent or extended idling (over 10 minutes per hour of normal driving).

②More often if operated in severe service or dust conditions. An instrument panel warning light will glow during normal engine operation when filter replacement is required.

③More frequent intervals may be required dependent on fuel quality and vehicle usage. An instrument panel warning light will glow when servicing is required, or when the ignition key is in the START position.

④Every 12 months or at mileage.

⑤For severe service only change fluid every 30,000 miles. The definition of severe service for automatic transmission is as follows:
The automatic transmission fluid should be changed every 30,000 miles (48 000 km) if your vehicle(s) operate under any of the following conditions:
— Sustained high speed driving during hot weather (+90°F, +32°C).
— Towing a trailer for long distances.
— Accumulating 5,000 miles (8 000 km) or more per month.
— Continuous running service.

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MAINTENANCE (Continued)

OWNER MAINTENANCE CHECKS

Listed below are vehicle maintenance checks and inspections that should be performed by the owner or qualified service technician at the indicated intervals. The Owner's Guide contains supporting specifications and service information.

Any adverse conditions should be brought to the attention of the dealer or qualified service technician as soon as possible.

These Owner Maintenance checks are generally not covered by warranties and the owner may be charged for labor, parts and lubricants used.

When an Owner Stops for Fuel:

- Check the engine oil level.
- Check the windshield washer fluid level.
- Look for low or under-inflated tires.

While Operating the Vehicle:

- Note any changes in the sound of the exhaust or any smell of exhaust fumes in the vehicle.
- Check for vibrations in the steering wheel. Notice any increased steering effort or looseness in the steering wheel, or change in its straight ahead position.
- Notice if the vehicle **constantly turns slightly** or "pulls" to one side when traveling on smooth, level road.
- When stopping, listen and check for strange sounds, **pulling to one side,** increased brake pedal travel or "hard" to push brake pedal.
- If any slipping or changes in the operation of the transmission occurs, check the transmission fluid level.
- Check automatic transmission PARK function.
- Check parking brake.

At Least Monthly:

- Check and adjust tire pressure (cold).
- Check coolant level in the coolant recovery reservoir.
- Check operation of lights, horn, turn signals, windshield wipers and washers, and hazard warning flasher.
- Check for fluid leaks by inspecting the surface beneath the vehicle for oil, coolant, or other fluid drips. Clean water from the air conditioning system is normal.

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MAINTENANCE (Continued)

OWNER MAINTENANCE CHECKS (Cont'd.)

At Least Twice a Year (i.e., Every Spring and Fall):

- Check power steering reservoir fluid level.
- Check fluid level in clutch master cylinder.
- Check radiator, heater and air-conditioning hoses for leaks or damage.
- Check for worn tires.
- Clean body and door drain holes.
- Flush complete underside of vehicle.
- Inspect underbody components for damage.
- Check exhaust system for leaks or damage.
  NOTE: It is normal for a certain amount of moisture and staining to be present around the muffler seams. The presence of soot, light surface rust or moisture does not indicate a faulty muffler.
- Check parking brake system.
- Check headlamp alignment.
- Check seat and shoulder belt webbing, buckles and release mechanisms.
- Inspect seat back latches for proper operation.
- Check air pressure in spare tire.

At Least Once a Year:

- Lubricate door hinges and checks and hood hinges.
- Lubricate door, hood and deck locks, and latches.
- Lubricate door rubber weatherstrips.
- Inspect and lubricate automatic transmission linkage and controls.
- Clean battery and terminals, check electrolyte level on low maintenance (auxiliary and replacement) batteries.
- Check manual transmission, 4x4 transfer case and rear axle fluid levels.

Tire Rotation:

Tire rotation is recommended by all tire and vehicle manufacturers to improve wear life and to avoid abnormal wear.

- Rotate your tires the first time between 5,000 and 7,500 miles (8,000-12,000 km) or earlier if there is any sign of uneven treadwear. This first rotation is most important.
- Subsequent tire rotations should be performed at 15,000 mile (24,000 km) maintenance intervals.

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SECTION 10-03 Lubrication Chart and Lubricant Specifications

SUBJECT	PAGE	SUBJECT	PAGE
LUBRICATION CHART	10-03-1	VEHICLE APPLICATION	10-03-1
SPECIFICATIONS	10-03-10		

VEHICLE APPLICATION

E-150—E-350, F-150—F-350, F-Super Duty and Bronco vehicles.

LUBRICATION CHART

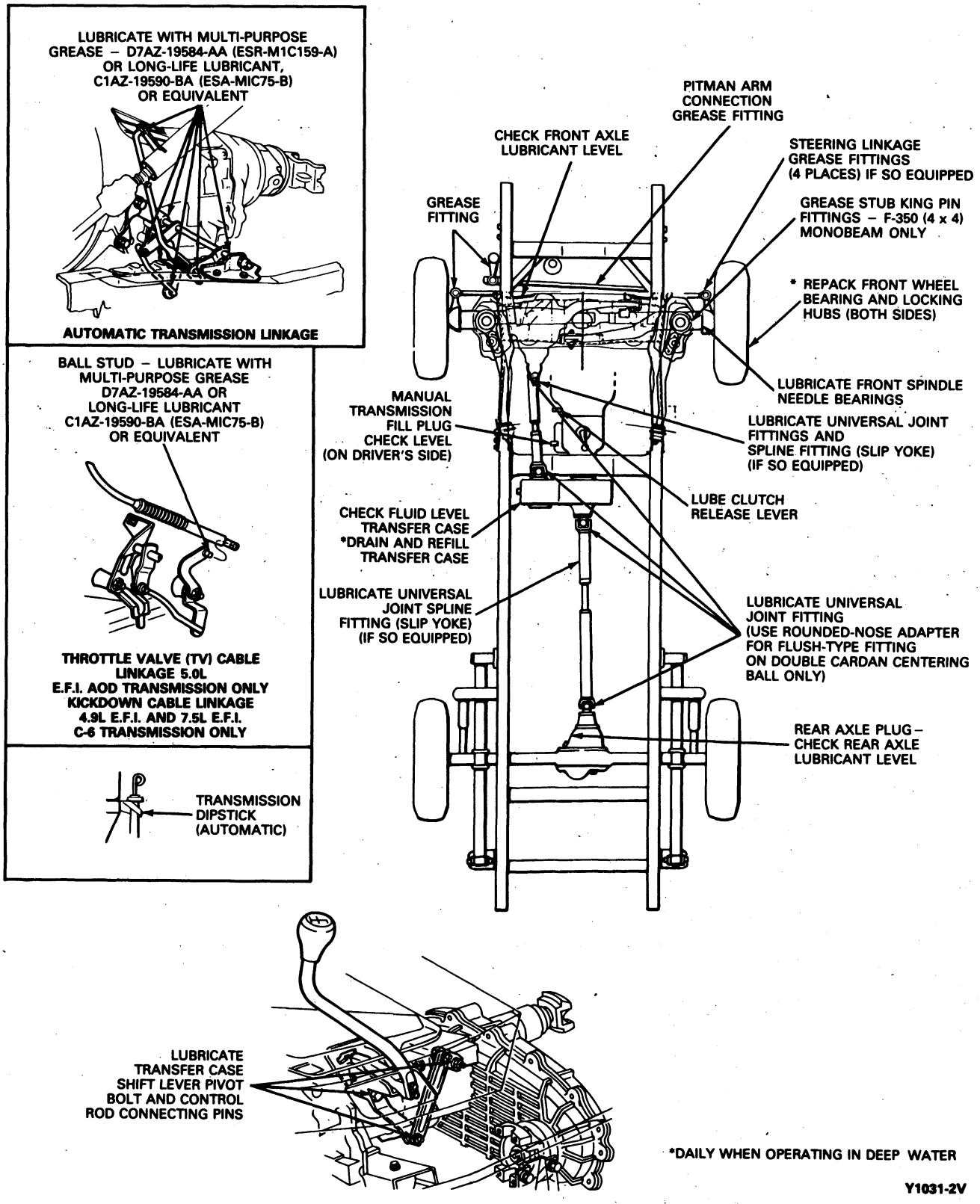
Important lubrication points for typical chassis and engines are shown in the following illustrations. Vehicles with optional equipment may have slightly different or additional lubrication points. When special equipment or accessories are installed on the truck, consult the manufacturer's literature for lubrication procedures. A table of recommended lubricants is included at the end of this Section.

WARNING: THE AMERICAN PETROLEUM INSTITUTE (API) HAS ANNOUNCED THAT CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. THE EFFECTS OF USED MOTOR OIL ON HUMANS HAS NOT BEEN ESTABLISHED. IT IS RECOMMENDED, HOWEVER, THAT AS A PRECAUTIONARY MEASURE, HUMANS PROTECT THEIR SKIN BY WASHING WITH SOAP AND WATER AFTER COMING IN CONTACT WITH USED MOTOR OIL.

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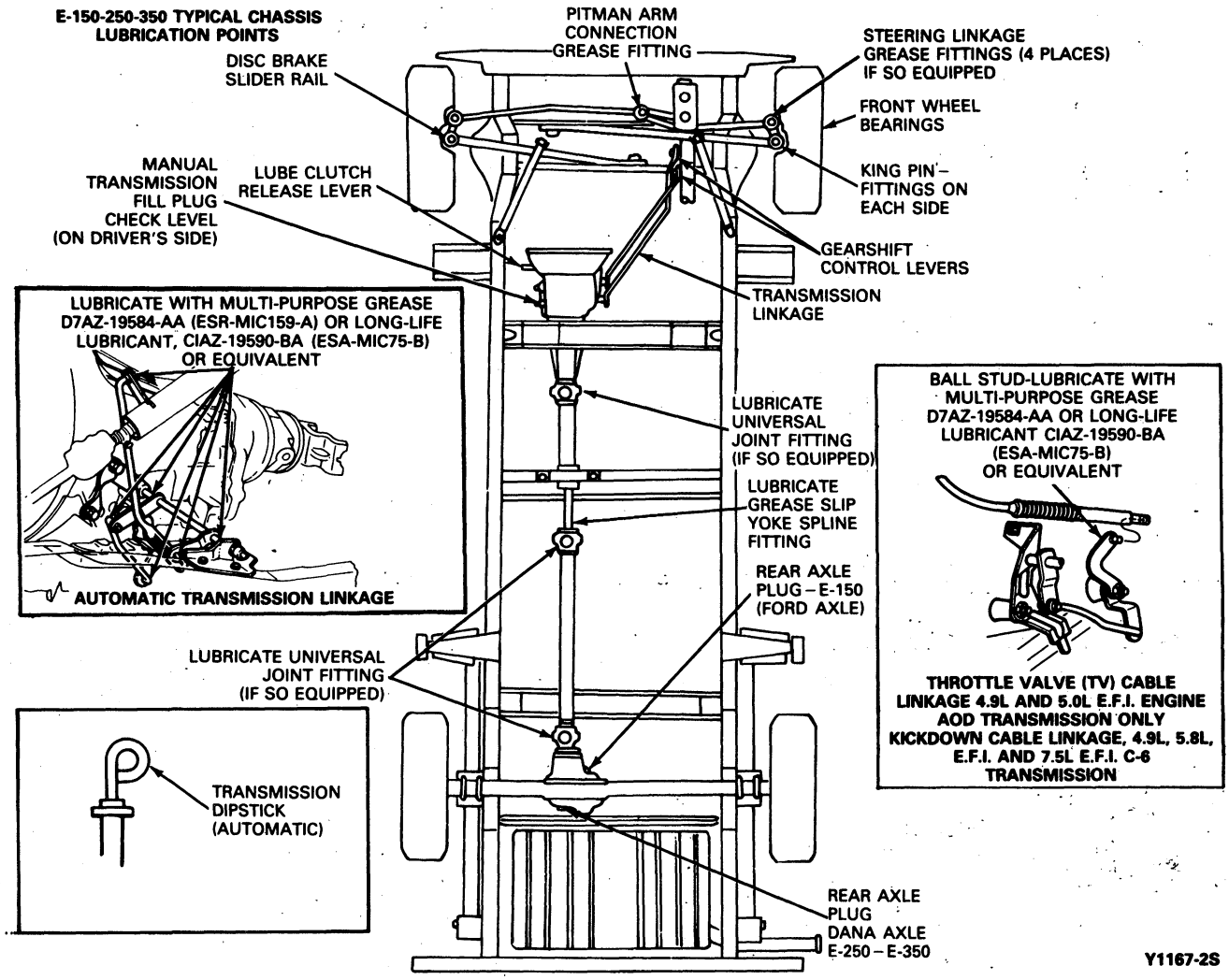
LUBRICATION CHART (Continued)

F-150-250-350 (4 x 4) AND BRONCO CHASSIS LUBRICATION POINTS



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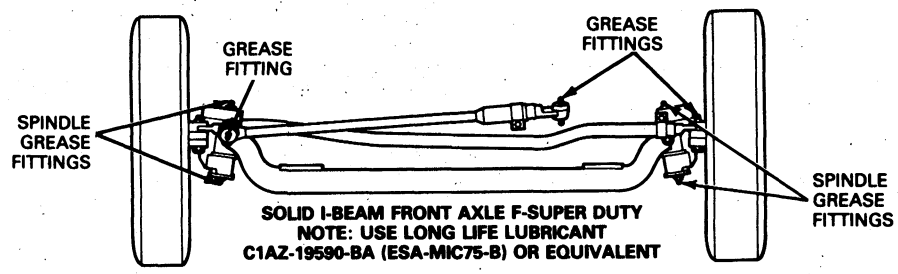
LUBRICATION CHART (Continued)



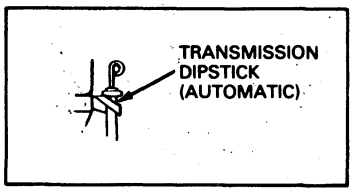
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LUBRICATION CHART (Continued)

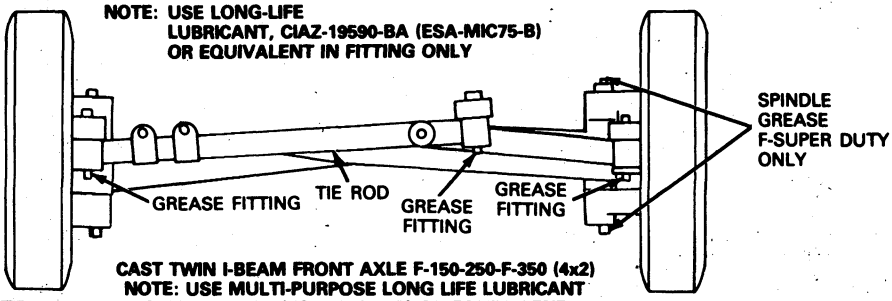
F-150-250-350 (4 x 2) AND F-SUPER DUTY CHASSIS LUBRICATION POINTS



SOLID I-BEAM FRONT AXLE F-SUPER DUTY
NOTE: USE LONG LIFE LUBRICANT C1AZ-19590-BA (ESA-MIC75-B) OR EQUIVALENT

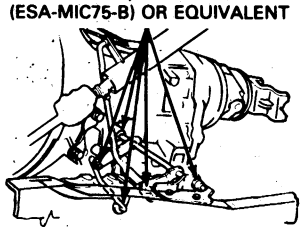


NOTE: USE LONG-LIFE LUBRICANT, C1AZ-19590-BA (ESA-MIC75-B) OR EQUIVALENT IN FITTING ONLY

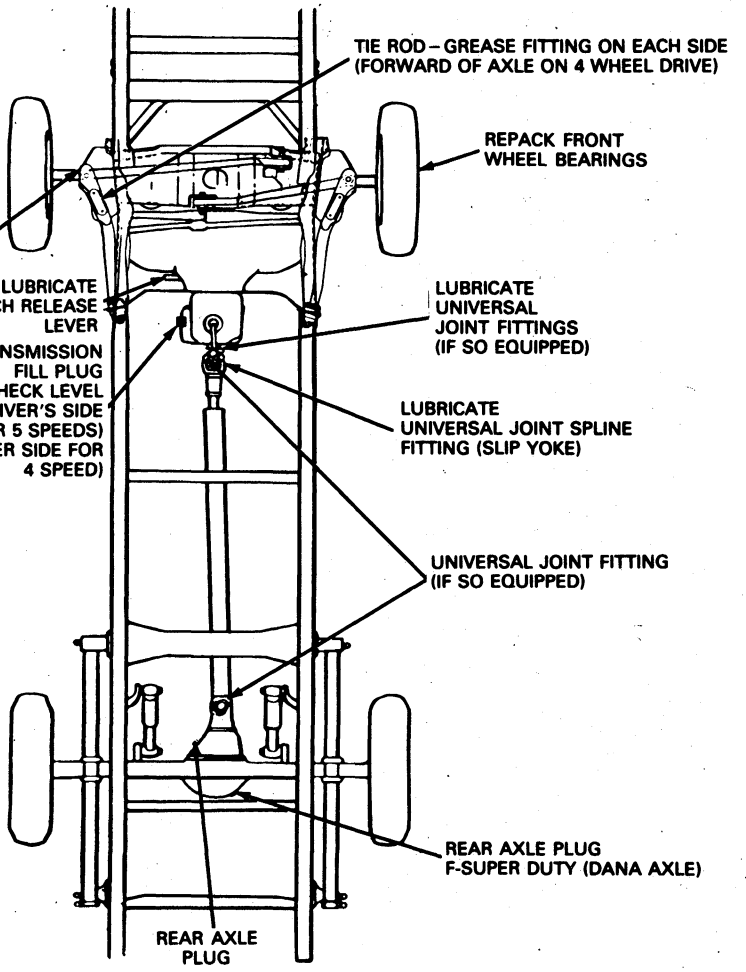


CAST TWIN I-BEAM FRONT AXLE F-150-250-F-350 (4x2)
NOTE: USE MULTI-PURPOSE LONG LIFE LUBRICANT C1AZ-19590-BA (ESA-M1C75-B) OR EQUIVALENT

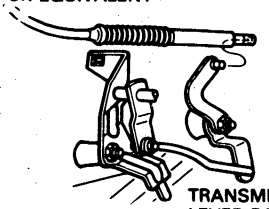
LUBRICATE WITH MULTI-PURPOSE GREASE-D7AZ-19584-AA OR LONG-LIFE LUBRICANT, C1AZ-19590-BA (ESA-MIC75-B) OR EQUIVALENT



AUTOMATIC TRANSMISSION LINKAGE



BALL STUD
LUBRICATE WITH MULTI-PURPOSE GREASE D7AZ-19584-AA OR LONG-LIFE LUBRICANT C1AZ-19590-BA (ESA-MIC75-B) OR EQUIVALENT



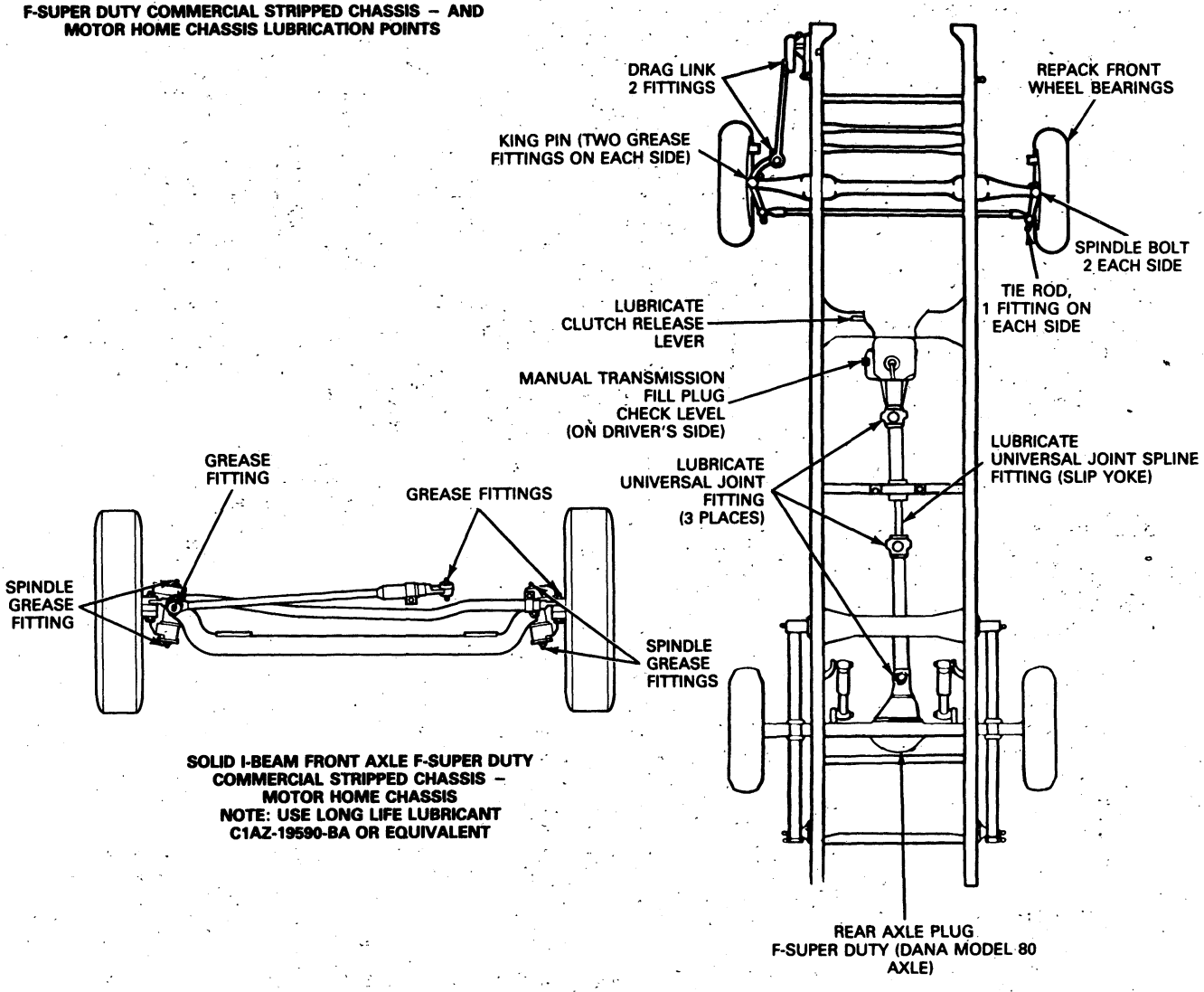
THROTTLE VALVE (TV) CABLE LINKAGE 4.9L AND 5.0L E.F.I. ENGINE AOD TRANSMISSION ONLY KICKDOWN CABLE LINKAGE, 4.9L E.F.I., 5.0L E.F.I. 5.8L E.F.I., 7.5L E.F.I.

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LUBRICATION CHART (Continued)

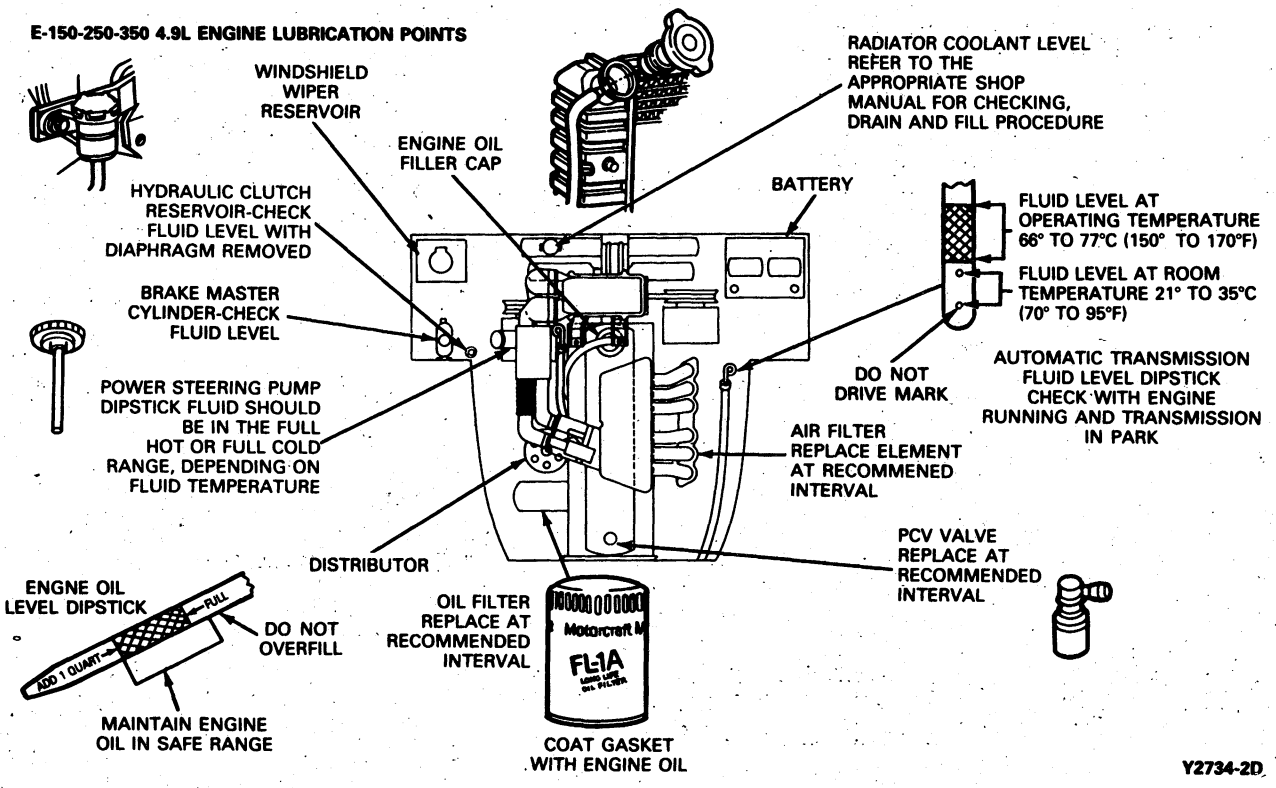
F-SUPER DUTY COMMERCIAL STRIPPED CHASSIS – AND MOTOR HOME CHASSIS LUBRICATION POINTS

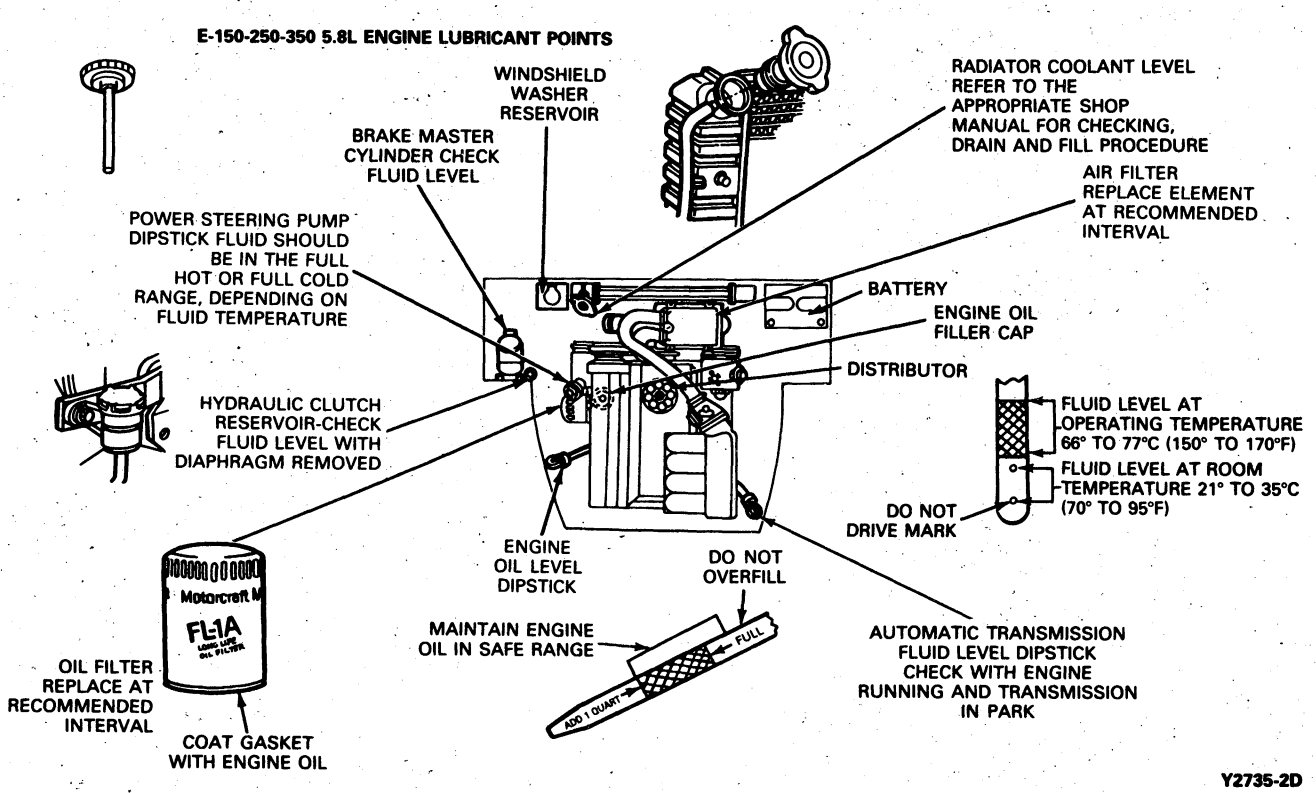


SOLID I-BEAM FRONT AXLE F-SUPER DUTY COMMERCIAL STRIPPED CHASSIS – MOTOR HOME CHASSIS
NOTE: USE LONG LIFE LUBRICANT C1AZ-19590-BA OR EQUIVALENT

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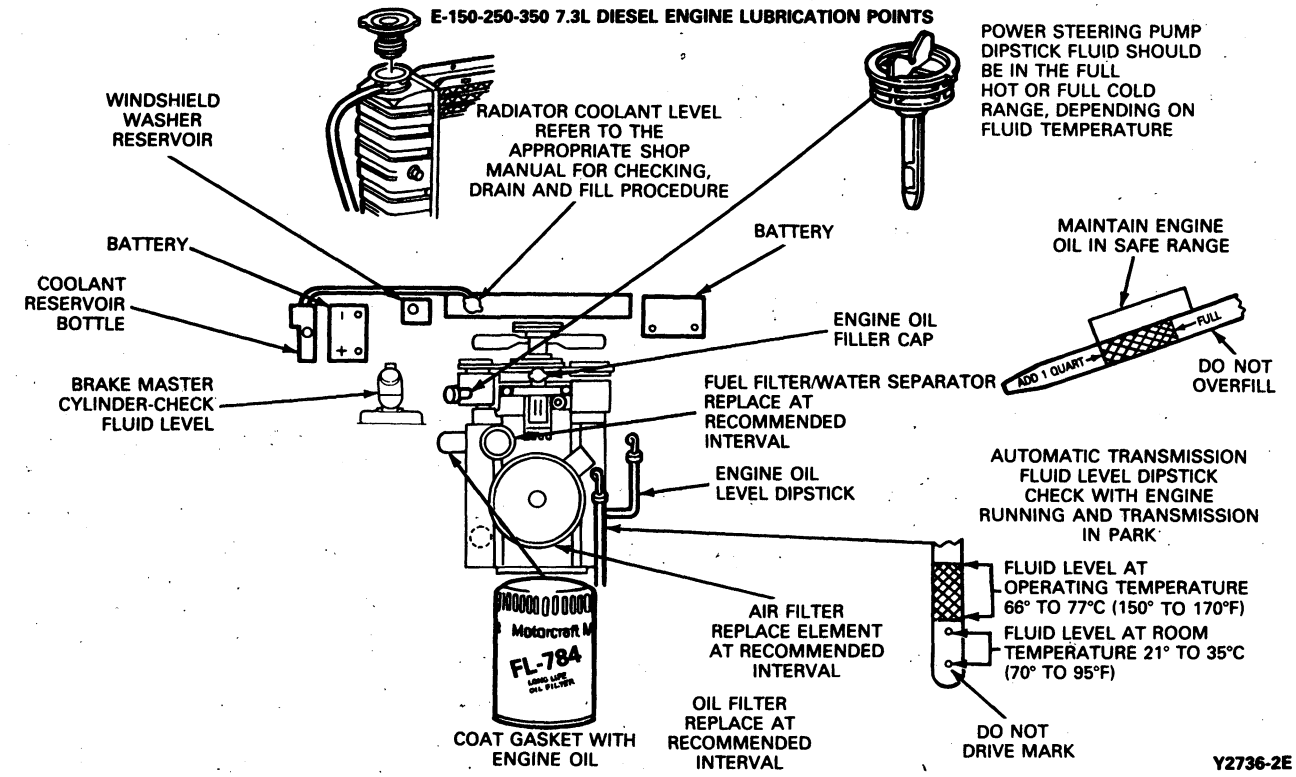
LUBRICATION CHART (Continued)

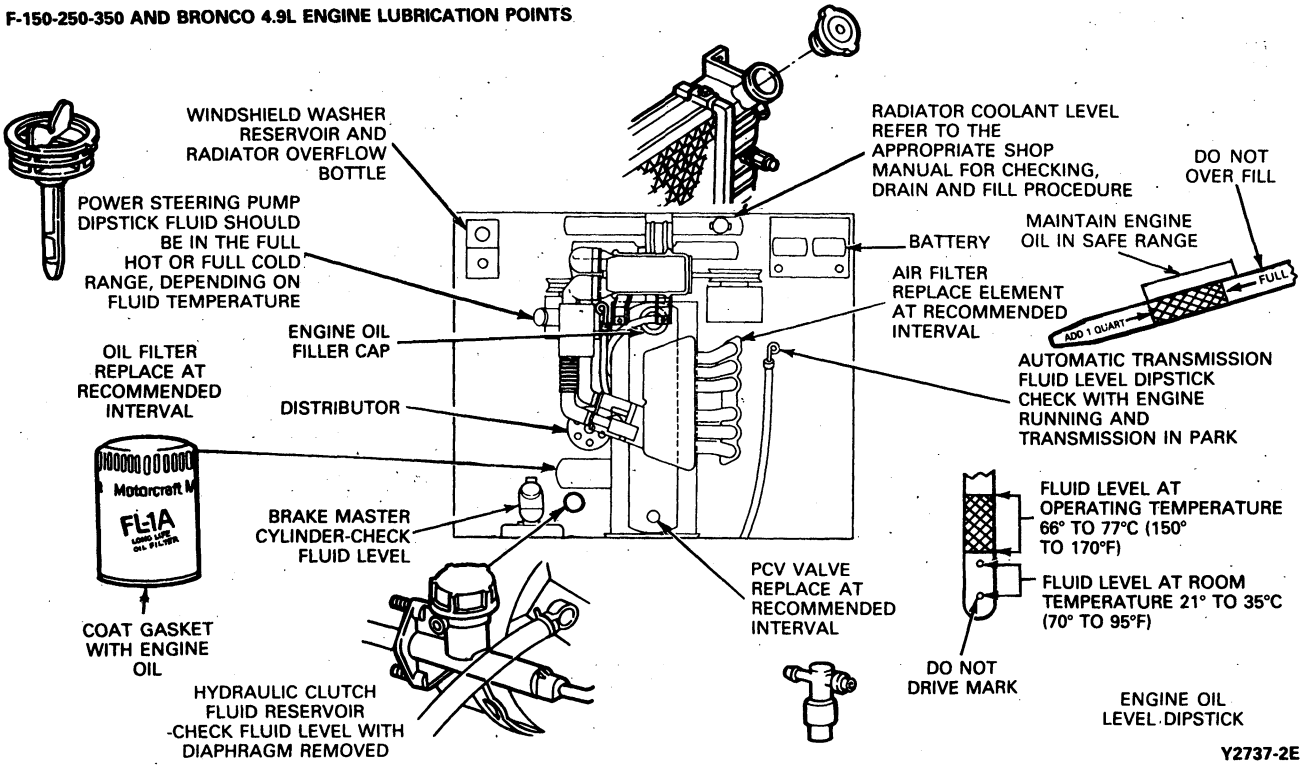




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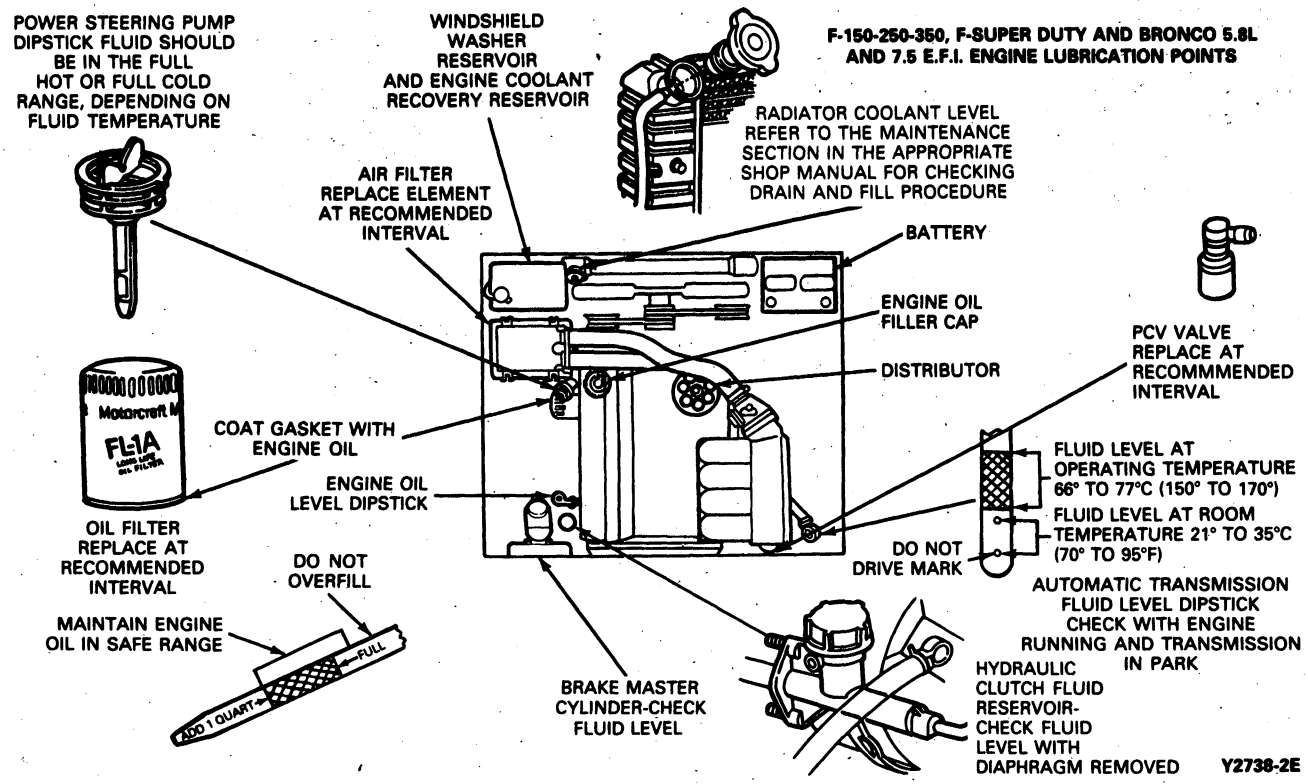
LUBRICATION CHART (Continued)

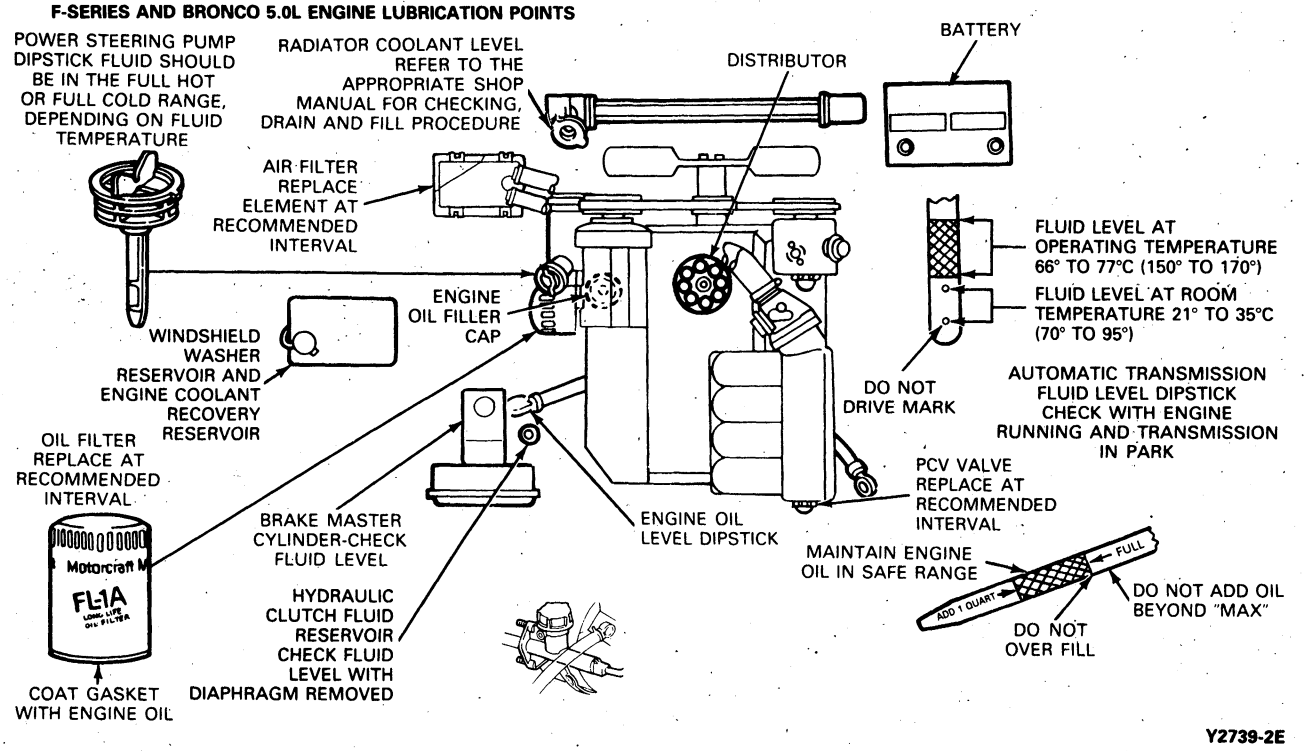




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LUBRICATION CHART (Continued)

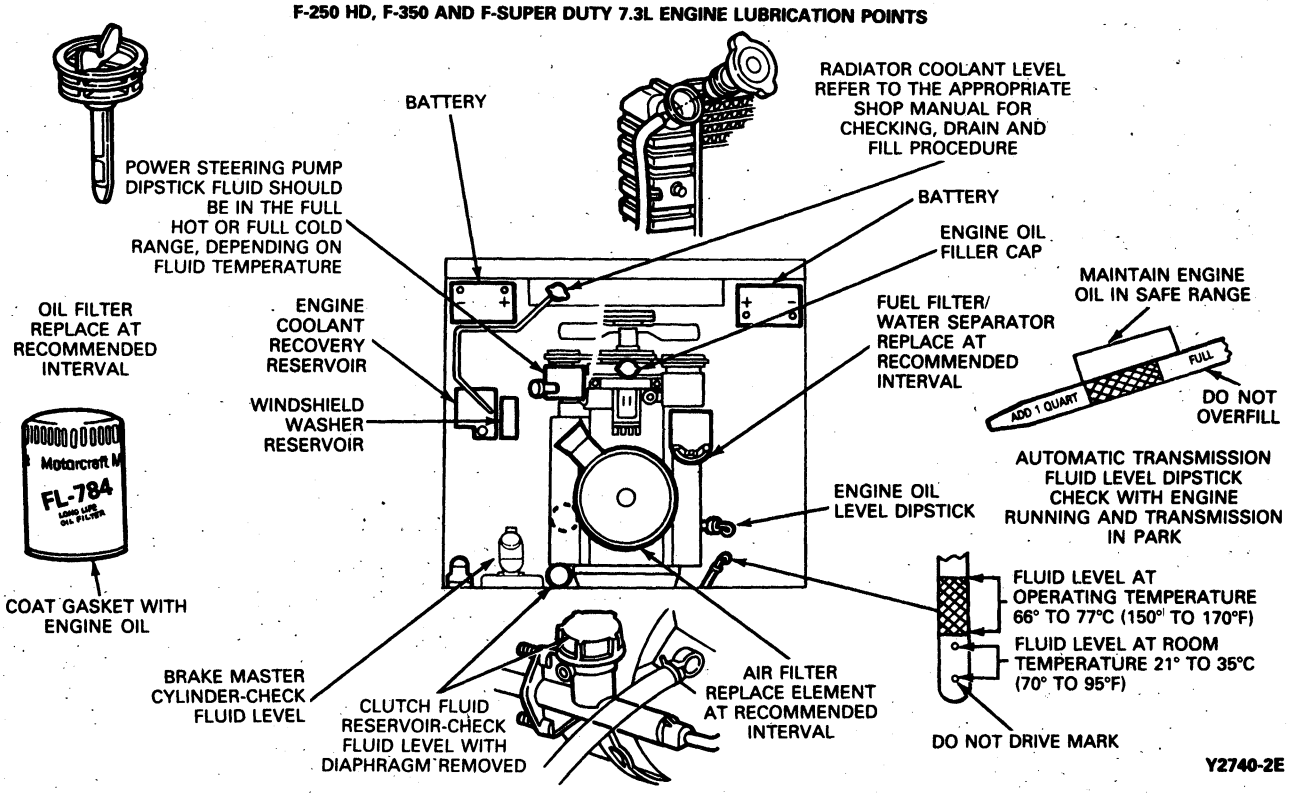




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LUBRICATION CHART (Continued)

F-250 HD, F-350 AND F-SUPER DUTY 7.3L ENGINE LUBRICATION POINTS



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SPECIFICATIONS

LUBRICANT SPECIFICATIONS — E-150 — E-250 — E-350, F-150 — F-250 — F-350, F-SUPER DUTY AND BRONCO

Item	Ford Part Name	Ford Part Number	Ford Specification
Windshield Washer Reservoir	Ultra-Clear Windshield Washer Solvent	C9AZ-19550-AA or BA	ESR-M17P5-A
Body Hinges, Latches, Door Striker Plates and Rotor, Seat Tracks, Door Tracks and Checks, Hood Latch and Auxiliary Latch, Spare Tire Carrier Latch	Multi-Purpose Grease	D7AZ-19584-AA	ESR-M1C159-A
Lock Cylinders, Outside Spare Tire Lock	Lock Lubricant	D8AZ-19587-AA	ESB-M2C20-A
Front Axle Spindle Pins, Front and Rear Spring Shackle Pins, Steering Column U-Joints, Clutch Linkage Fittings, Universal Joints, Joints with Zerk Fittings, and Slip Yoke Pivots, Parking Brake Linkage Pivots and Clevises, Transmission Control Linkage Pivots	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Front Wheel Bearings and Rear Wheel Bearings Brake and Clutch Pedal Shaft	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
4x4 Front Drive Axle, U-Joints, Wheel Bearings and Spindle Needle Bearings	TBD	TBD	ESA-M1C198-A
Power Steering Reservoir	Premium Power Steering Fluid	XT-1-QF or E6AZ-19582-AA	ESW-M2C33-F
Clutch Release Lever at Pivots	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Engine Oil — All Gasoline Engines	Motorcraft Motor Oil 5W30 and 10W40 Super Premium 10W30 and 20W40 Premium SAE-30 and 15W40 Super Duty	XO-5W30-QSP XO-10W40-QP XO-10W30-QP XO-20W40-QP XO-30-QSD XO-15W40-QSD	ESE-M2C153-E and API SG or SG/CE
Engine Oil — Diesel② (Consult respective engine owners guide for recommendations)	Motorcraft Motor Oil 15W40 Super Duty SAE-30 Super Duty	XO-15W40-QSD XO-30-QSD	API SG/CE or SG/CD or ESE-M2C153-E
Engine Oil Filter — Diesel	Oil Filter	E3TZ-6731-A (FL-784)	—
Engine Oil Filter — Gasoline	Motorcraft Long Life Oil Filter	D9AZ-6731-A (FL-1A)	ES-E1ZE-6714-AA
C6 E4OD and AOD Automatic Transmission	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX	ESP-M2C166-H
Accelerator Control Kickdown (Automatic 6 Cyl.)	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Speedometer, Parking Brake Cable	Speedometer Cable Lubricant	D2AZ-19581-A	ESF-M1C160-A
Steering Linkage — Lubricate only where equipped with grease fittings	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Accelerator Linkage — Ball Socket	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Ford Axles (Conventional and Limited-Slip) ③	Hypoid Gear Lubricant	E0AZ-19580-AA	ESP-M2C154-A
Transfer Case — Four-Wheel Drive	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX	ESP-M2C166-H
Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins	Long Life Lubricant	C1AZ-19590-BA	ESA-MIC75-B
Front and/or Rear Dana Axles and Dana Limited Slip Rear Axles ①	Hypoid Gear Lubricant	C6AZ-19580-E	ESW-M2C105-A
4-Speed Manual Transmission — Warner T18④	Standard Transmission Lube	D8DZ-19C547-A	ESP-M2C83-C
Release Bearing for Clutches with Concentric Slave Cylinders	Long Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Release Bearing for Conventional Systems	Long Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
5-Speed Manual Overdrive Transmission — Mazda	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX	ESP-M2C166-H

① Add 8 oz. of Friction Modifier C8AZ-19B546-A EST-M2C118-A or equivalent to refill Dana limited slip axles.
② For arctic winter operation below −25°C (−10°F) but not above −7°C (20°F), use engine oil SAE 5W-30 SG/CD or SG/CE.
③ For Ford design rear axles: Add 4 oz. of Friction Modifier C8AZ-19B546-A EST-M2C118-A for complete refill of 8.8 inch ring gear limited slip rear axles. For F-250, F-350 with 10.25 inch ring gear limited slip rear axles add 8 oz. of Friction Modifier C8AZ-19B546-A EST-M2C118-A.
④ Requires 6.5 pints.

CY2439-2H

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SPECIFICATIONS (Continued)

LUBRICANT SPECIFICATIONS — E-150 — E-250 — E-350, F-150 — F-250 — F-350, F-SUPER DUTY AND BRONCO (Cont'd.)

Item	Ford Part Name	Ford Part Number	Ford Specification
5-Speed Manual Overdrive Transmission ZF(S5-42)	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX	ESP-M2C166-H
Automatic Transmission Shift Linkage	Multi-Purpose Grease	D7AZ-19584-AA	ESR-M1C159-A
Transmission Throttle Valve (TV) Lever — AOD Only Transmission Kickdown Lever C6 (EFI Engines)	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Disc Brake, Caliper Rails	Disc Brake Caliper Slide Grease	D7AZ-19590-A	ESA-M1C172-A
F-Super Duty Parking Brake	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX	ESP-M2C166-H
Hydraulic Brake Master Cylinder — Hydraulic Clutch Master Cylinder①	Heavy-Duty Brake Fluid	C6AZ-19542-AA or BA	ESA-M6C25-A
Brake and Clutch Pedal Pivots and Clevises	Engine Oil SAE-10W	—	ESE-M2C153-E API-SG
Manual Locking Hubs ON 4x4	Steering Gear Grease	C3AZ-19578-A	ESW-M1C87-A
Driveshaft, Universal Joints (if equipped with fitting), Slip Yoke and Spring Stud Shackles Except Stripped Chassis and Motor Home Chassis	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Driveshaft, Universal Joints and Slip Yoke F-Super Duty Stripped Chassis and Motor Home Chassis	High Temperature Grease NLGI, No. 2	—	ESL-M1C173-A
Exhaust Control Valve	Rust Penetrant and Inhibitor	D7AZ-19A501-AA	ESR-M99C56-A
Engine Coolant	Premium Cooling System Fluid	E2FZ-19549-AA	ESE-M97B44-A
Door Weatherstrips	Silicone Lubricant	C0AZ-19553-AA	ESR-M13P4-A
Drive Shaft, Slip Yoke, Double Cardan Joint Center Ball	Long-Life Lubricant	C1AZ-19590-BA	ESA-M1C75-B
Automatic Locking Hubs — 4x4	Automatic Hublock Grease	E1TZ-19590-A	ESL-M1C193-A

①As the clutch disc wears, the fluid level in the reservoir will rise. Fluid level above the "step" is an indication of disc wear, NOT overfill. **CY2440-2H**

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SECTION 10-04 Hoisting, Jacking and Towing

SUBJECT	PAGE
HOISTING	
Bronco, E-150—E-250—E-350, F-150—F-250—F-350,	10-04-1
JACKING	10-04-1
TOWING	
General Wrecker Towing Procedure	10-04-2
TOWING (Cont'd.)	
Towing Slings/Chains/Hooks	10-04-3
TOWING CONNECTIONS—LIGHT TRUCK	
Front Wheels Off Ground	10-04-4
Rear Wheels Off Ground	10-04-11
VEHICLE APPLICATION	10-04-1

VEHICLE APPLICATION

E-150 Through E-350, F-150 Through F350, F-Super Duty and Bronco vehicles.

HOISTING

Bronco, E-150—E-250—E-350, F-150—F-250—F-350, and F-Super Duty

Damage to suspension and/or steering linkage components may occur when positioning hoist adapters. Front adapter (pads) should be positioned carefully to ensure maximum contact under the center of the lower suspension arms or spring supports as near wheels as practical. Rear suspension hoist adapters (forks) should be placed under spring mounting pads or rear axle housing, but adapters must not interfere with shock absorber mounting brackets.

When raising a vehicle on a twin post hoist, care should be taken to position the vehicle so that the hoisting forks do not damage the axle carrier casting or rear cover.

JACKING

WARNING: TO MINIMIZE THE RISK OF PERSONAL INJURY, DO NOT PUT ANY PORTION OF YOUR BODY UNDER THE VEHICLE WHILE THE VEHICLE IS ON THE JACK. THE JACK IS PROVIDED FOR EMERGENCY WHEEL AND TIRE CHANGING ONLY.

WARNING: ON VEHICLES EQUIPPED WITH A TRACTION-LOC AXLE, NEVER RUN THE ENGINE WITH ONE WHEEL OFF THE GROUND, SUCH AS WHEN CHANGING A TIRE. THE WHEEL STILL ON THE GROUND COULD CAUSE THE VEHICLE TO MOVE.

When lifting a vehicle with the vehicle jack or any floor jack, block the diagonally opposite wheel to prevent vehicle from moving.

CAUTION: On vehicles equipped with an under chassis mounted spare tire, remove the tire, wheel or tire carrier from the vehicle before it is placed in a high lift position in order to avoid sudden weight release from the chassis.

Position floor jacks under axles, radius arms or spring hangers as close to the wheels as possible. Refer to the owner's manual and jacking decal.

To raise heavy vehicles with floor jacks, follow the jack manufacturer's recommendations for placement of jack. Do not exceed the rated lift capacity of any jack.

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TOWING

General Wrecker Towing Procedure

E-150—E-250—E-350; F-150—F-250—F-350—F-Super Duty and Bronco

Preparatory Steps

Release the parking brake and place the transmission in neutral. As a general rule, towed vehicles should be pulled with the driving wheels off the ground. If the vehicle is to be towed on its drive wheels, the transmission and differential must be operable. If not, place the rear wheels on a dolly or disconnect the rear driveshaft.

When a vehicle is towed on its front wheels, the steering wheel must be clamped in the straight ahead position with a steering wheel clamping device designed for towing service use, such as those provided by towing system manufacturers.

Do not use the vehicle's steering column lock to lock the wheels in a straight ahead position when pulled from the rear. If the ignition key is not available, place a dolly underneath the driving wheels of the vehicle and tow with the non-driving wheels raised.

Towing 4-wheel drive manual shift vehicles are to be handled as follows:

1. Transmissions (automatic or manual) should be placed in N (neutral).
2. On vehicles equipped with manual hubs, place hubs in FREE position.
3. Place transfer case in neutral.

CAUTION: Improper towing of the vehicle could result in transmission and/or transfer case damage. Always follow the outlined towing procedures. It is recommended that only an unloaded vehicle be towed when either the front or rear wheels are off the ground.

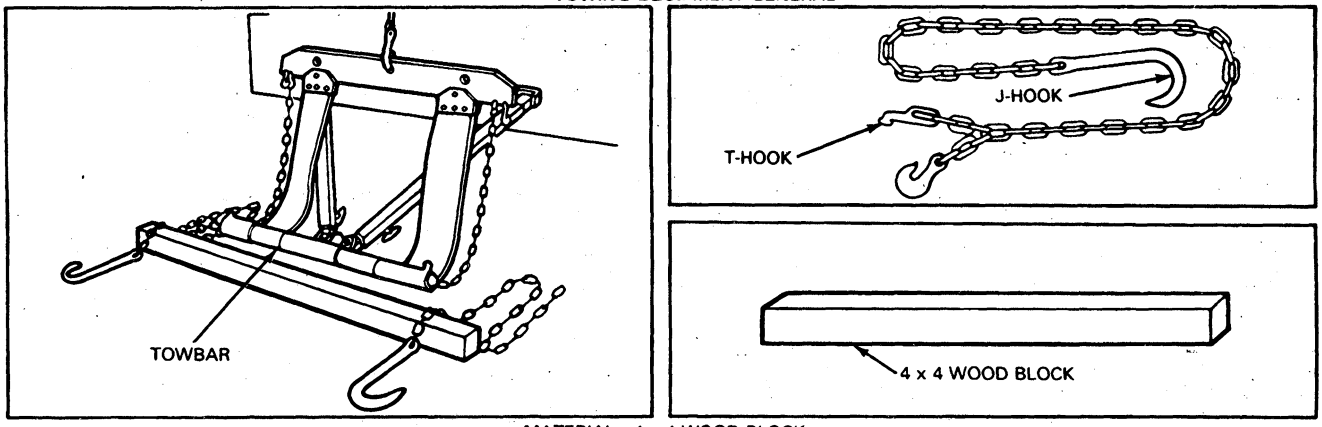
Towing 4-wheel drive vehicles with Touch Drive Electric Shift Transfer Case are to be handled as follows:

1. Transmission (automatic or manual) should be placed in N (neutral).
2. Transfer case should be in 2H (high).

NOTE: Both 4x4 and LOW RANGE indicator lights in the overhead console will be OFF when the transfer case is in 2H (high).

3. Automatic locking hubs should be disengaged.
4. Once these three conditions are met, follow instructions for towing 2-wheel drive vehicles.

TOWING EQUIPMENT-GENERAL



MATERIAL - 4 x 4 WOOD BLOCK
2×4 LUMBER ACTUALLY MEASURES 1-1/2" × 3-1/2"
4×4 LUMBER ACTUALLY MEASURES 3-1/2" × 3-1/2"

Y2731-2D

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TOWING (Continued)

If towing with a minimal load is unavoidable, care must be taken to properly restrain load from shifting and distribute the load evenly in the pickup box.

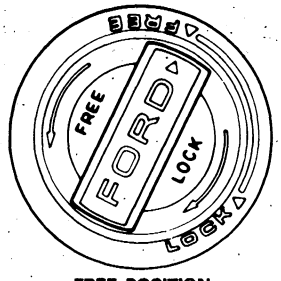
Towing Slings/Chains/Hooks

To avoid metal to metal contact and possible damage to chrome or lower body panels, a special wide-belt sling should be used to lift and tow ALL trucks. When attaching towing slings, take care to avoid damage to the license plate and frame, and air dam.

CAUTION: Use caution when attaching tow hooks and safety chains to vehicle. Position and remove hooks with care to avoid damage to brake hoses, brake lines and steering linkage components.

NOTE: On vehicles equipped with bumper guards, make sure the towbar is under the bumper and the weight of the vehicle is not supported by the bumper guards.

UNLOCKING MANUAL HUBS
TWO-WHEEL DRIVE



FREE POSITION Y3355-1A

Towing Speeds

4x2 Vehicles

On 4x2 vehicles, when towing with the rear wheels on the ground, or all four wheels on the ground, do not exceed a maximum speed of 56 km/h (35 mph) and a maximum distance of 80 km (50 miles).

On 4x2 vehicles, when towing with the rear wheels off the ground, do not exceed a maximum speed of 80 km/h (50 mph). There is no maximum distance for towing.

4x4 Vehicles

When towing 4x4 vehicles, do not exceed a maximum speed of 56 km/h (35 mph) and a distance of 80 km (50 miles). If a vehicle is to be towed above this speed or distance, both driveshafts must be disconnected at the axles and wired to the under carriage.

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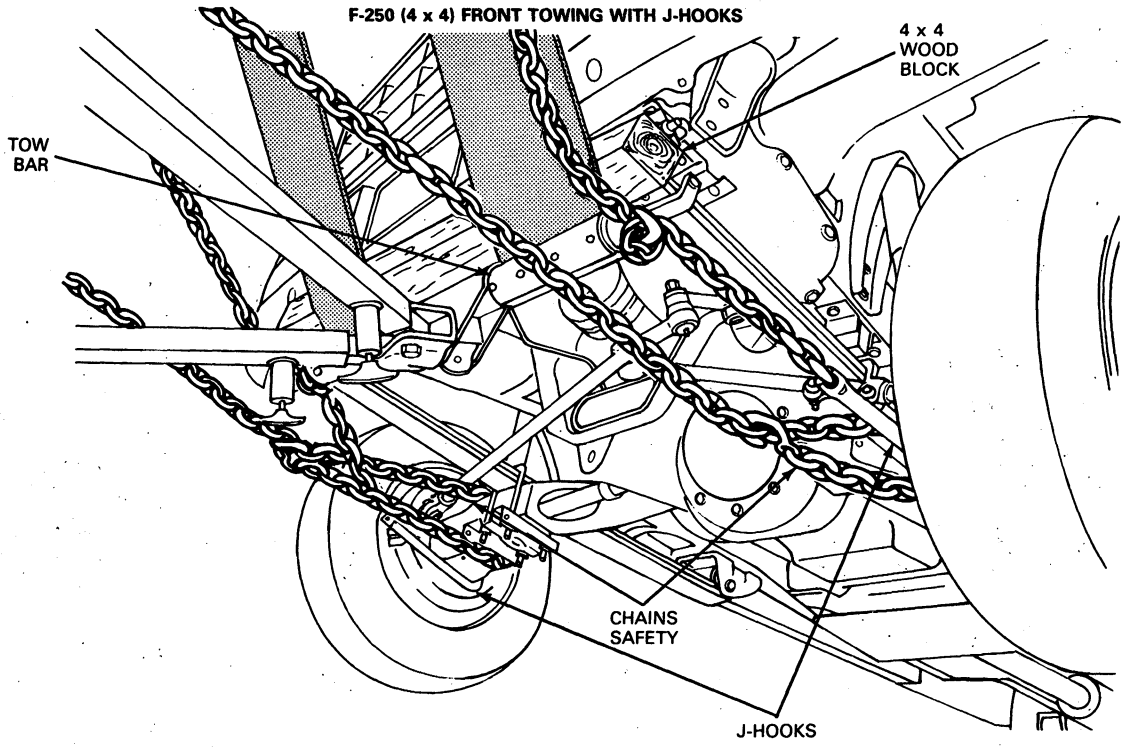
TOWING CONNECTIONS—LIGHT TRUCK

Front Wheels Off Ground

F-250 (4x4) Front Towing With J-Hooks

1. Attach J-hooks under axle outboard of the leaf spring.
2. Position 4x4 on sling under shackle.
3. Position towbar against 4x4.
4. Attach safety chains around axle support arm outboard of leaf spring.

CAUTION: Use of T-hooks is not recommended for F-250 (4x4).



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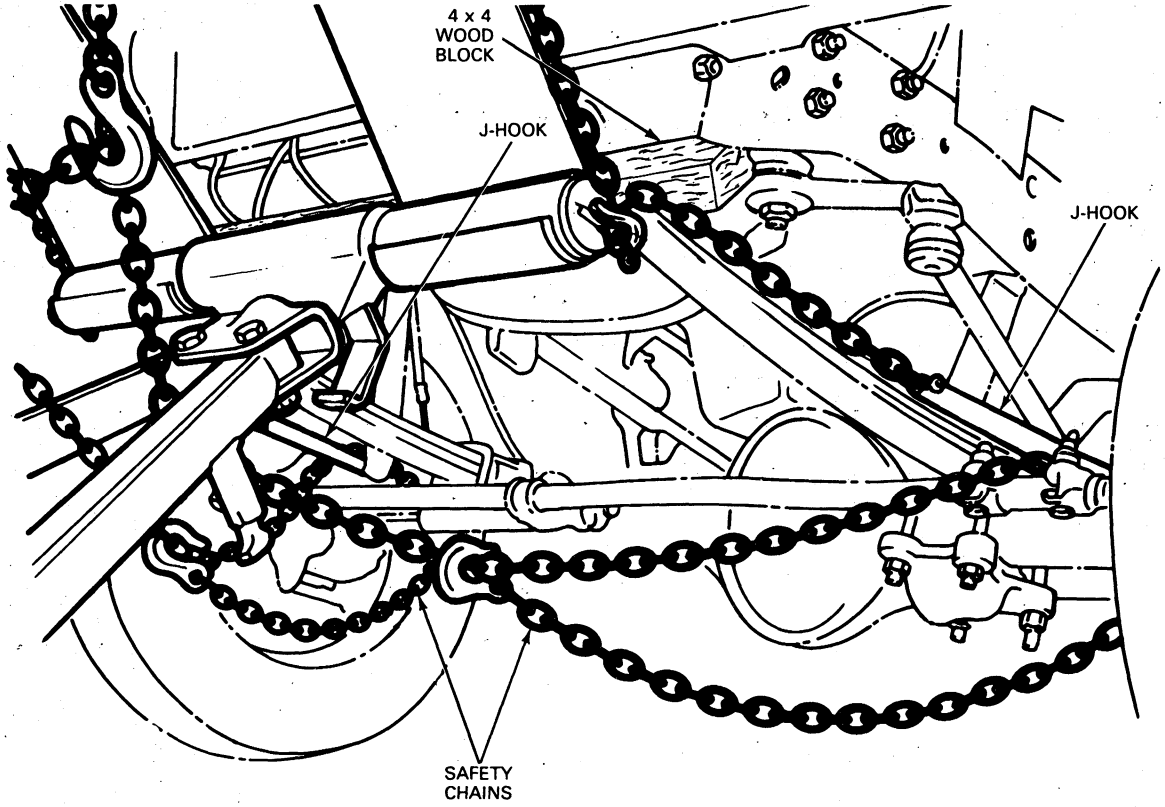
TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-350 (4x4)—Dana Monobeam Front Drive Axle—Front Towing With J-Hooks

CAUTION: Use of T-hooks is not recommended for F-350 (4x4) monobeam front drive axle.

1. Attach J-hooks outboard of the leaf springs over the axle from above the tie rod (hook in inverted position) as shown.
2. Position 4x4 on spring under shackle.
3. Position towbar against 4x4.
4. Attach safety chains around axle outboard of leaf spring.

F-350 (4 x 4) FRONT TOWING WITH J-HOOKS



Y1991-2C

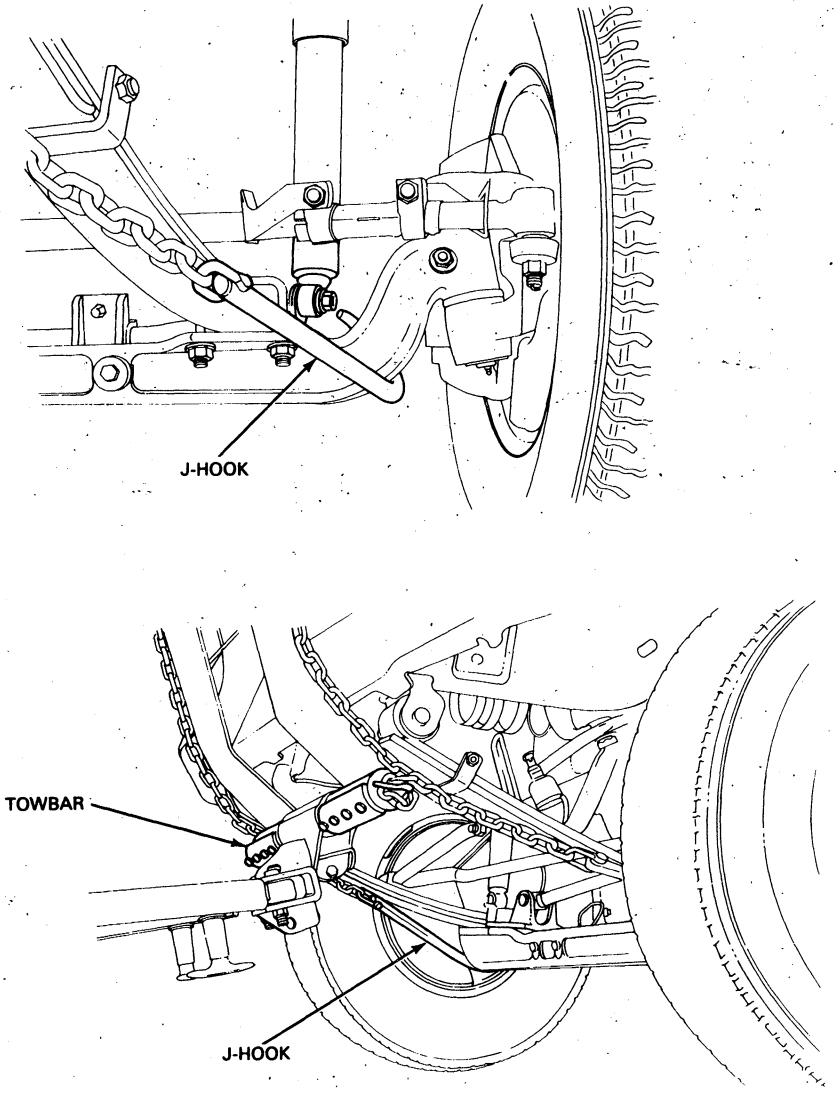
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-Super Duty—Front Towing with J-Hooks

1. Attach J-hooks to the axle outboard of the leaf spring (as shown).
2. Position towbar behind bumper.
3. Attach safety chains around axle outboard of leaf spring.

F-SUPER DUTY – FRONT TOWING WITH J-HOOKS



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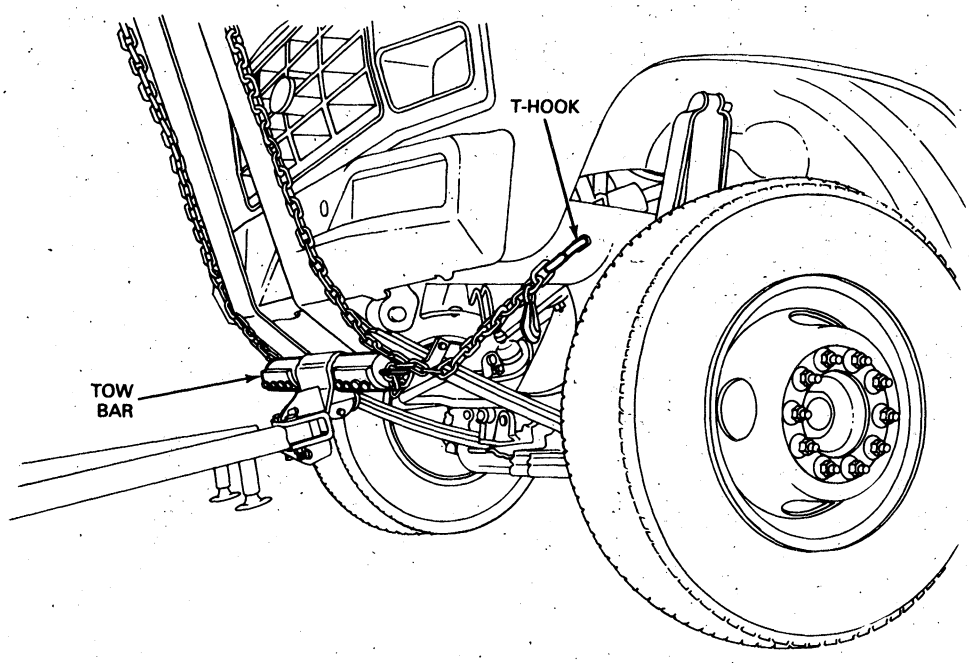
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-Super Duty—Front Towing with T-Hooks

1. Insert T-hooks in T-hook slot in frame from outboard of leaf spring (as shown).
2. Position towbar behind bumper.
3. Attach safety chains to front axle outboard of leaf springs.

F-SUPER DUTY – FRONT TOWING WITH T-HOOKS



Y3357-2A

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-150—F-350 (4x2), F-150 (4x4) and Bronco—Front Towing With J-Hooks

NOTE: Use of J-hooks are not recommended for vehicles equipped with stabilizer bar. Use T-hooks only.

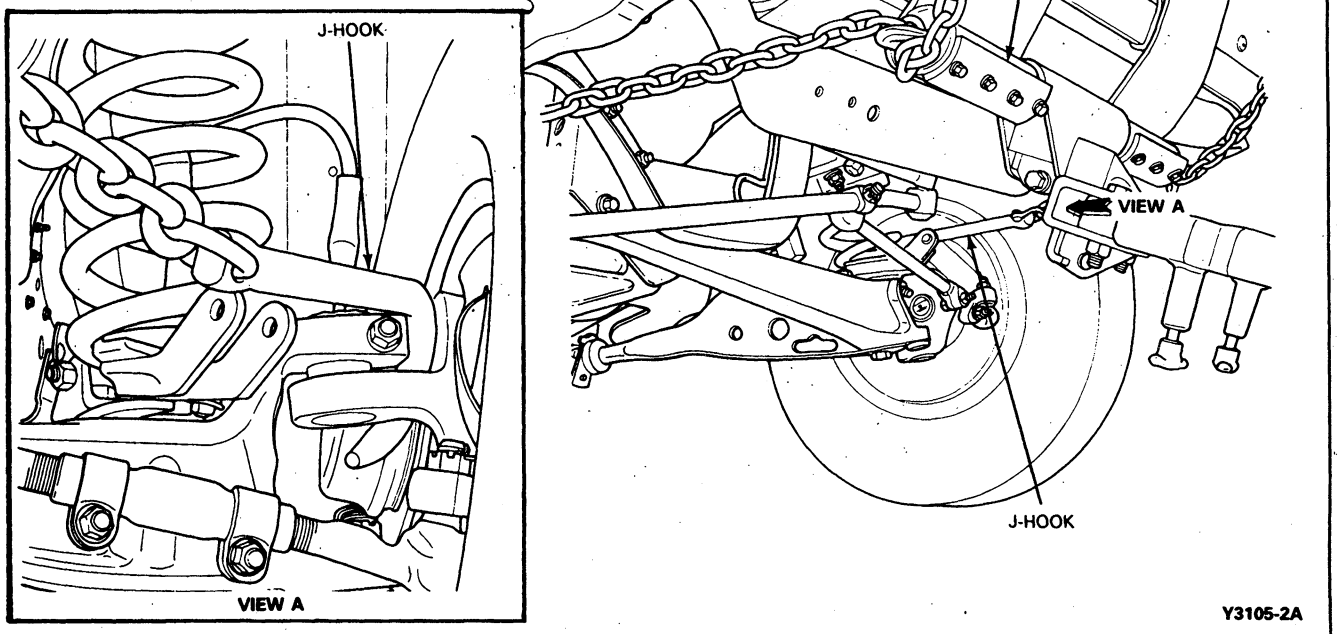
CAUTION: On vehicles equipped with an air dam, the towbar will deform the rubber air dam. Wheel lift equipment may be advisable.

1. Attach J-hooks over I-beam axle outboard of coil spring.

CAUTION: On F-150 (4x4) do not place the hook around the axle shaft. This area is open (open knuckle design) and could damage the journal cross and bearings on the axle shaft assembly.

2. Place a 4x4 on frame behind air dam.
3. Position towbar against 4x4.
4. Attach safety chains around I-beam axle outboard of the coil spring.

FRONT TOWING - J-HOOKS - F-150 - 250 - 350 (4 X 2), F-150 (4 X 4) AND BRONCO



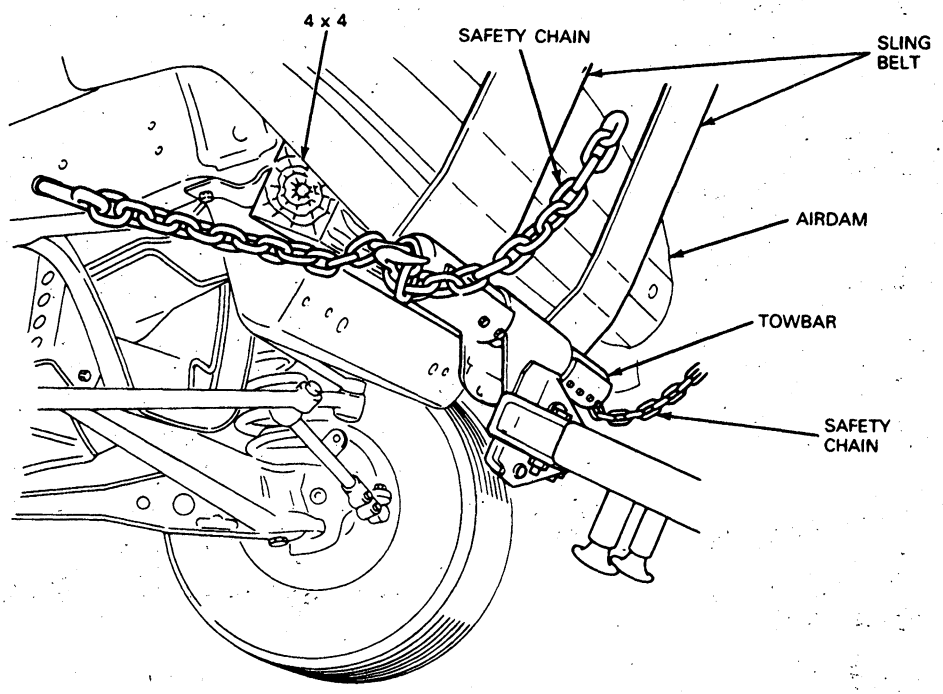
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-150—F-350 (4x2), F-150 (4x4) and Bronco—Front Towing With T-Hooks

CAUTION: On vehicles equipped with an air dam, the towbar will deform the rubber air dam. Wheel lift equipment may be advisable.

1. Insert T-hook in T-hook slot in frame.
2. Place 4x4 on frame behind air dam.
3. Position towbar against 4x4.
4. Attach safety chains around axle outboard of coil spring.



F-150-250-350 (4 x 2), F-150 (4 x 4) AND BRONCO FRONT TOWING WITH T-HOOKS

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

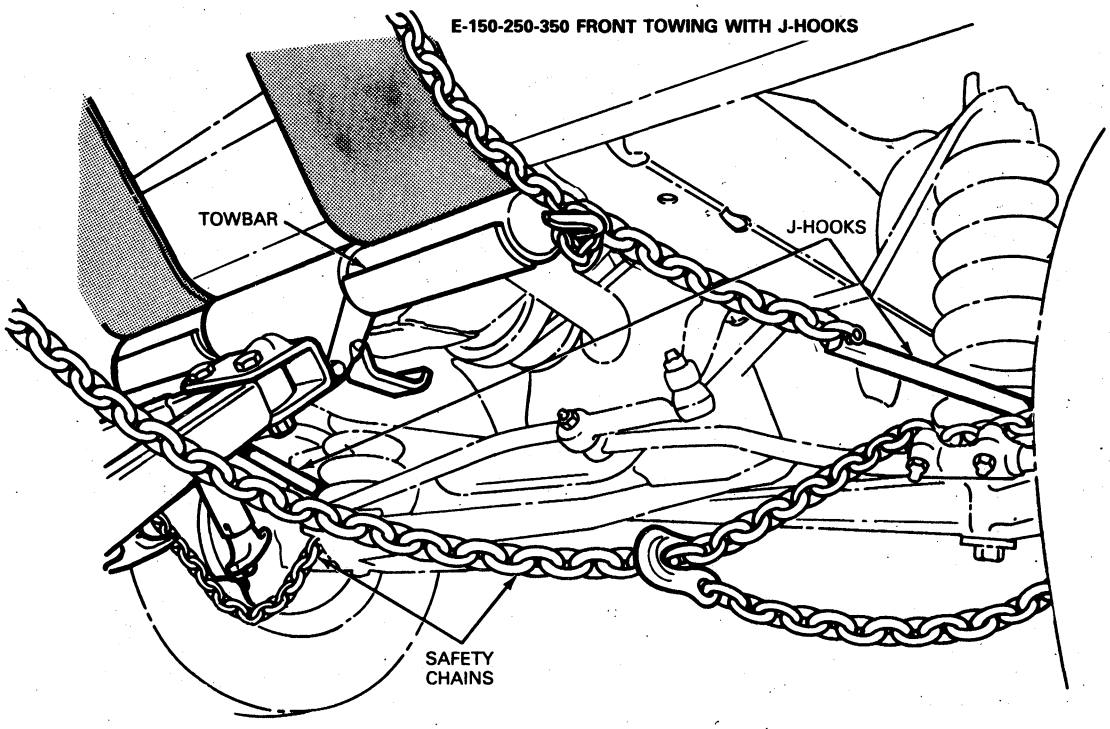
E-150/E-250/E-350 Front Towing With J-Hooks

CAUTION: Do not use a 4x4 under the frame to clear the air dam. A 4x4 will damage the radiator.

CAUTION: A towbar will deform the air dam. Wheel lift equipment is recommended.

1. Attach J-hooks outboard of the coil springs over the I-beam suspension arms from above the tie rod (hook in inverted position).
2. Position towbar behind bumper.
3. Attach safety chains around axle outboard of coil springs.

E-150-250-350 FRONT TOWING WITH J-HOOKS



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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

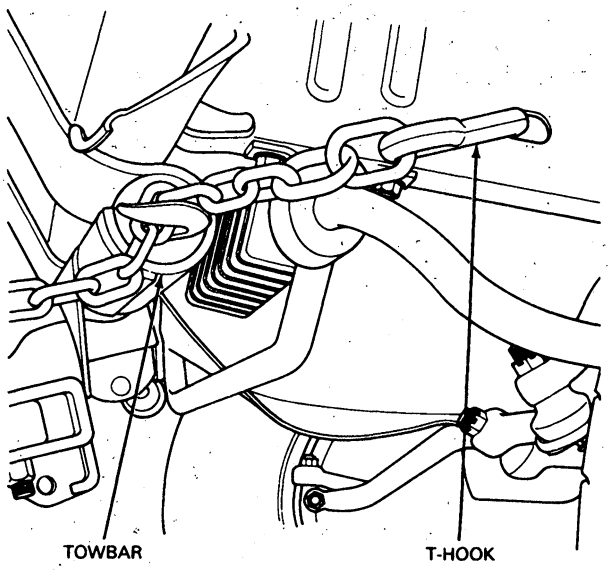
E-150—E-250—E-350 Front Towing With T-Hooks

CAUTION: On vehicles equipped with an air dam, the towbar will deform the rubber air dam. Wheel lift equipment may be advisable.

CAUTION: Do not use a 4x4 under the frame to clear the air dam. A 4x4 will damage the radiator.

1. Insert T-hooks in horizontal T-hook slot in frame.
2. Position towbar behind bumper.
3. Attach safety chains around axle outboard of coil springs.

E-150-250-350 FRONT TOWING WITH T-HOOKS



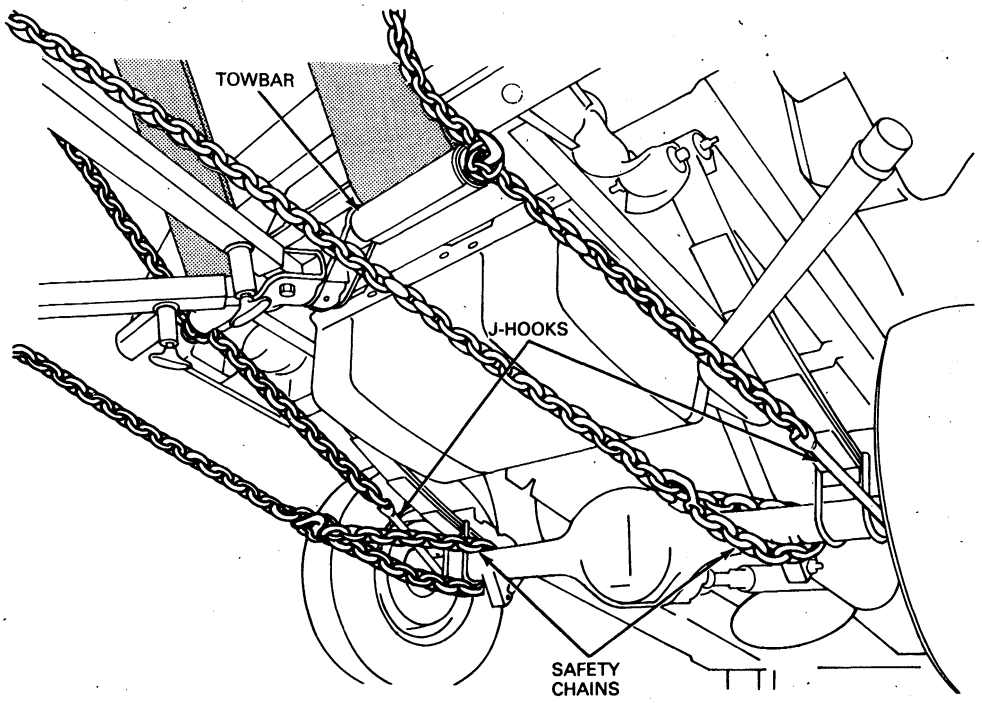
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Rear Wheels Off Ground

Bronco Rear Towing With J-Hooks

1. Attach J-hooks under axle outboard of leaf springs.
2. Position towbar under bumper on frame.
3. Attach safety chains around axle inboard of leaf spring seat.

BRONCO REAR TOWING WITH J-HOOKS



Y2095-2D

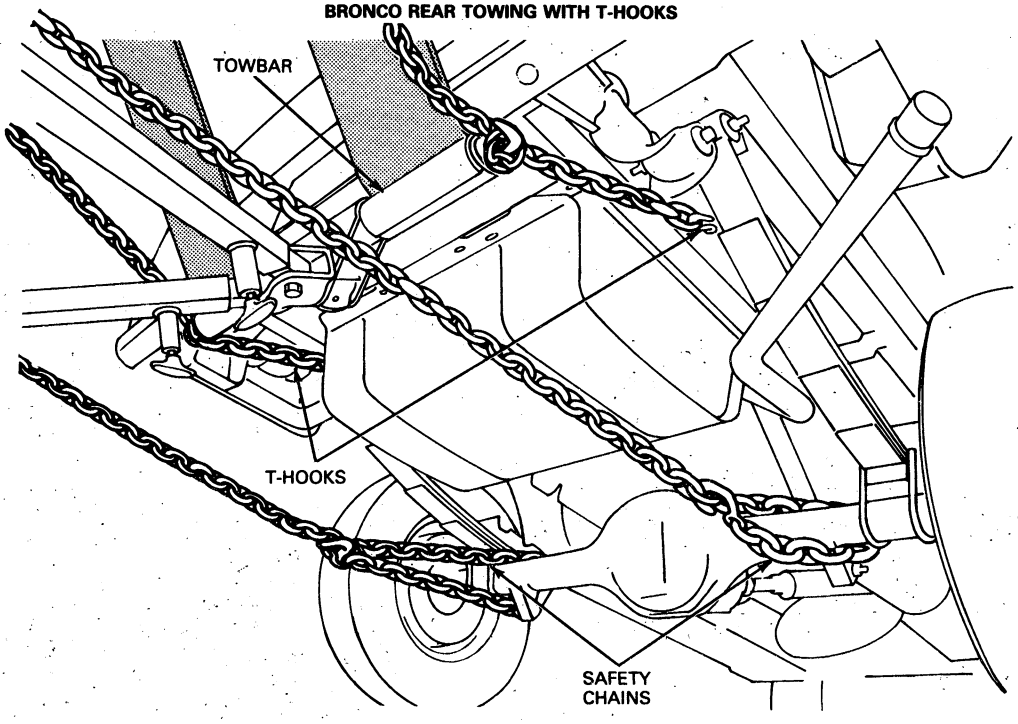
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

Bronco Rear Towing With T-Hooks

1. Insert T-hooks in horizontal T-hook slot in frame.
2. Position towbar under bumper.
3. Attach safety chains around rear axle inboard of leaf spring seat.

BRONCO REAR TOWING WITH T-HOOKS



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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

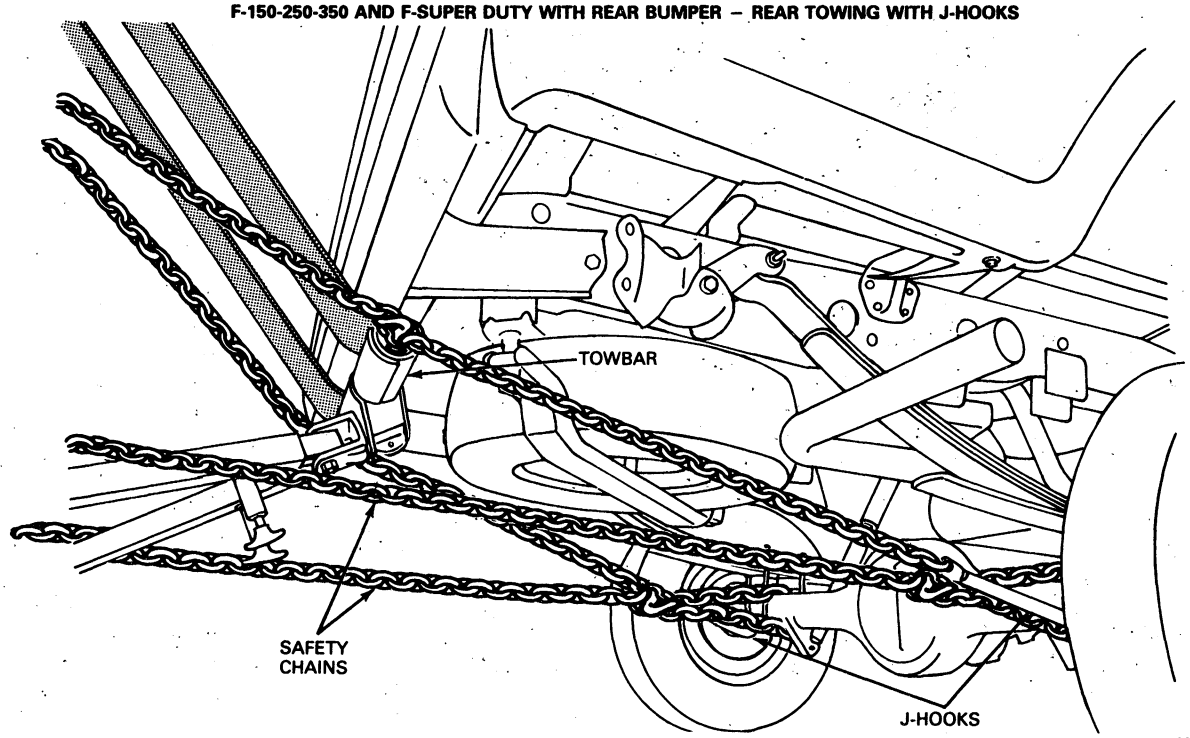
F-150—F-250—F-350 (4x2) (4x4) and F-Super Duty Rear Towing With J-Hooks

1. Attach J-hook under axle outboard of spring seat.

NOTE: A 4x4 wood block is required to be placed against the rear spring brackets on vehicles not equipped with a rear bumper. If the vehicle is also equipped with an under frame spare tire, the tire must be removed to allow installation of the 4x4 wood block.

2. Position towbar under bumper.
3. Attach safety chains around axle inboard of the leaf spring seat.

F-150-250-350 AND F-SUPER DUTY WITH REAR BUMPER – REAR TOWING WITH J-HOOKS

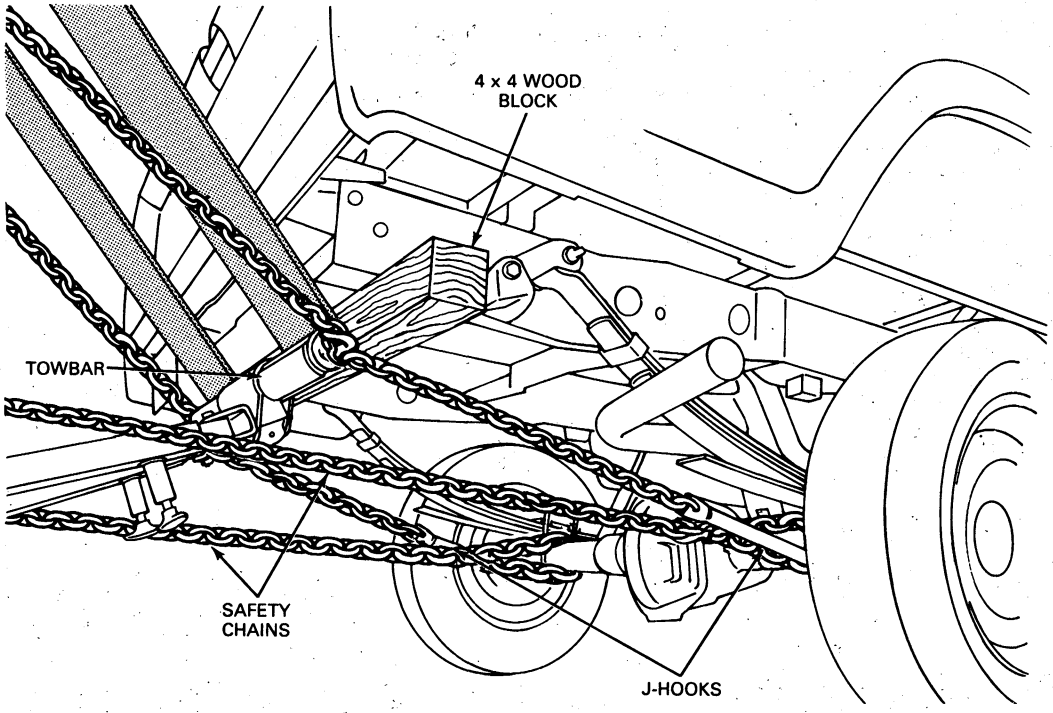


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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-150-250-350 AND F-SUPER DUTY WITHOUT REAR BUMPER – REAR TOWING WITH J-HOOKS



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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

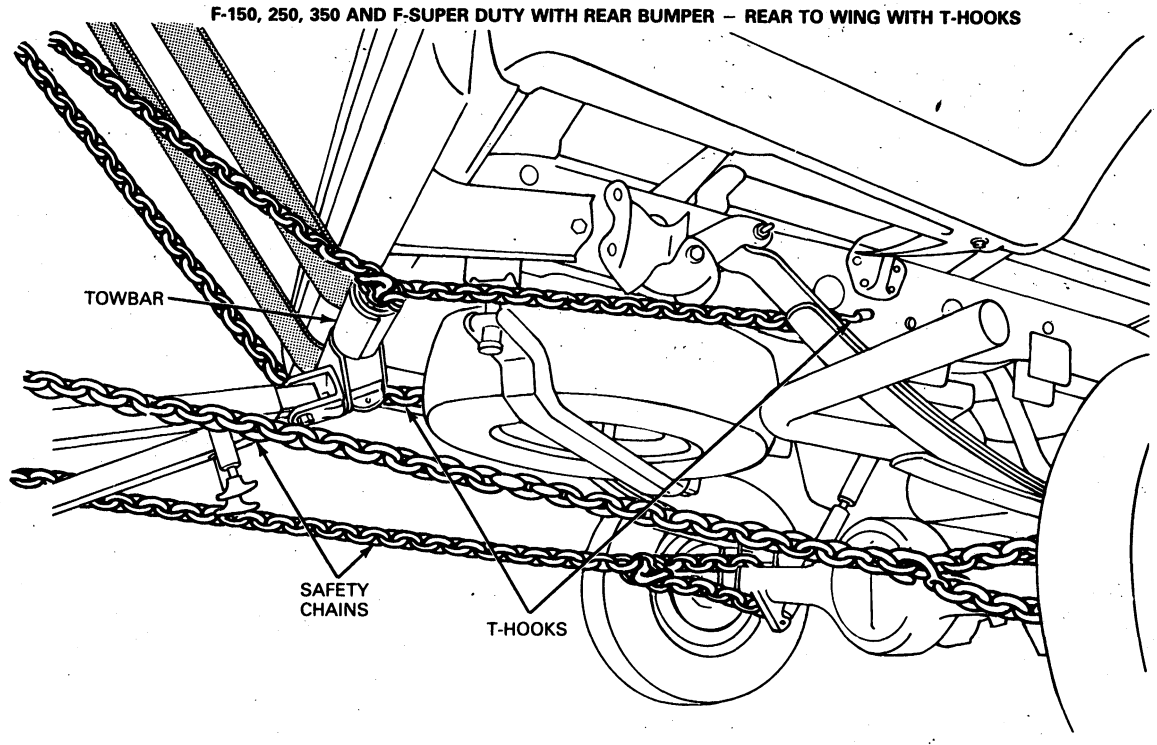
F-150—F-250—F-350 (4x2) (4x4) and F-Super Duty Rear Towing With T-Hooks

1. Position T-hooks in horizontal T-hook slot in frame.

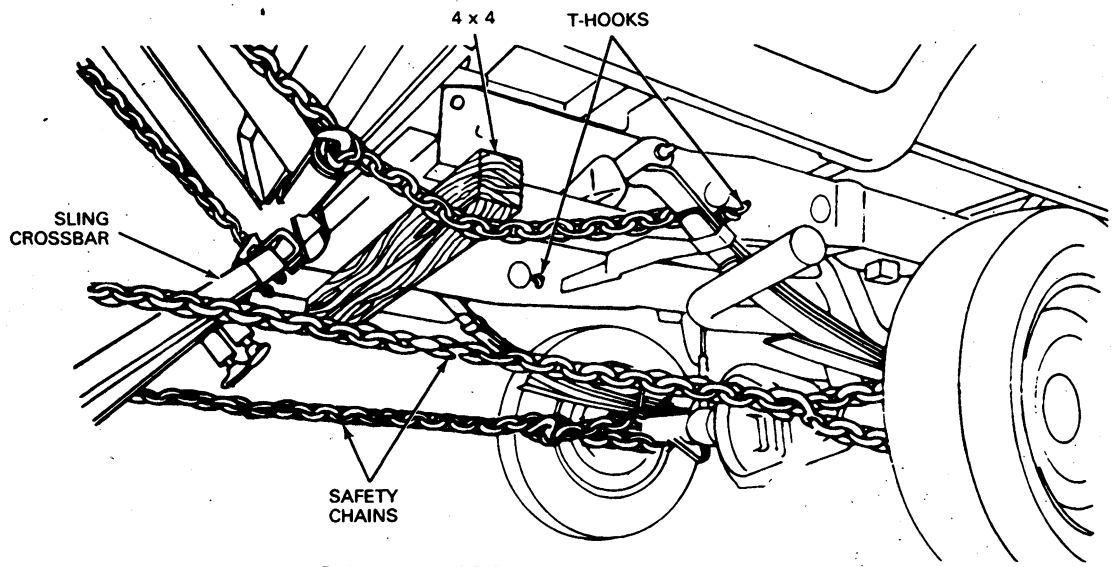
NOTE: A 4x4 wood block is required to be placed against the rear spring brackets on vehicles not equipped with a rear bumper. If the vehicle is also equipped with an underframe spare tire, the tire must be removed to allow installation of the 4x4 wood block.

2. Place towbar under bumper.
3. Attach safety chains around the axle inboard of the leaf spring seat.

F-150, 250, 350 AND F-SUPER DUTY WITH REAR BUMPER – REAR TO WING WITH T-HOOKS



Y2099-2D



F-150-250-350 AND F-SUPER DUTY WITHOUT REAR BUMPER REAR TOWING WITH T-HOOKS

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

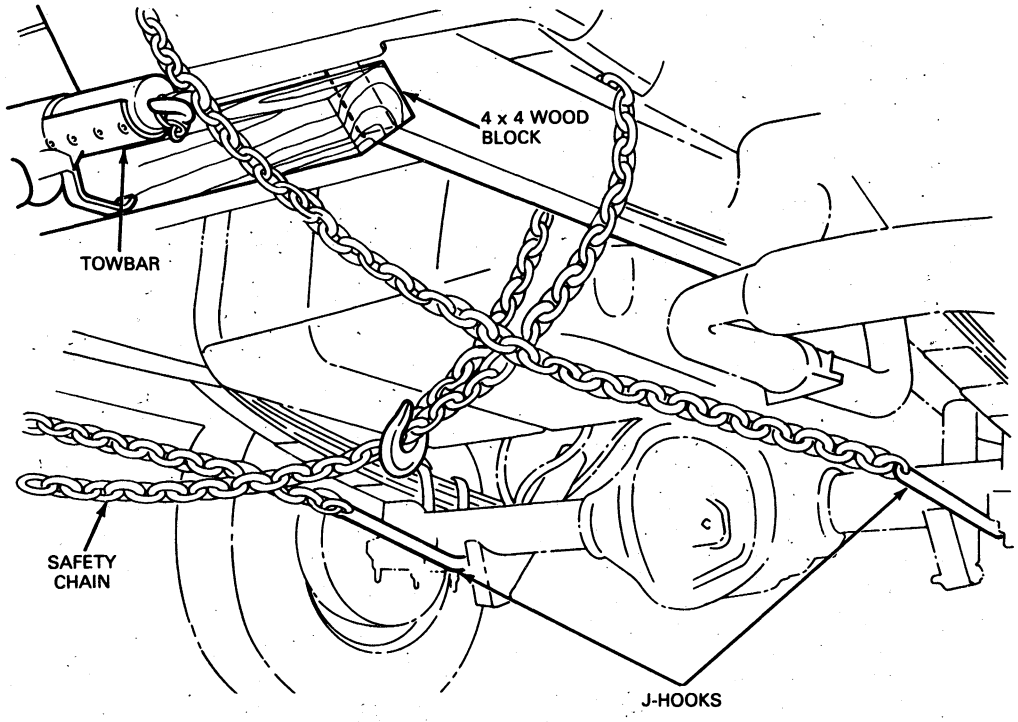
E-150—E-250—E-350 Rear Towing With J-Hooks

1. Attach J-hooks under the axle inboard of the leaf springs.
2. Position a 4x4 wood block across frame rails ahead of the bumper. Position the towbar against the 4x4 wood block rear face.

CAUTION: This hookup is designated to minimize the risk of bumper damage during normal towing. It is important that sling crossbar be tight against the 4x4 wood block lower rear face to minimize rear bumper tow load. The 4x4 wood block must be located ACROSS the frame rails and NOT under the bumper.

3. Attach safety chains around the frame rails or axle.

E-150-250-350 – REAR TOWING WITH J-HOOKS



Y2126-2F

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

E-150—E-250—E-350 (with Frame Mounted Rear Bumper) Rear Towing With T-Hooks

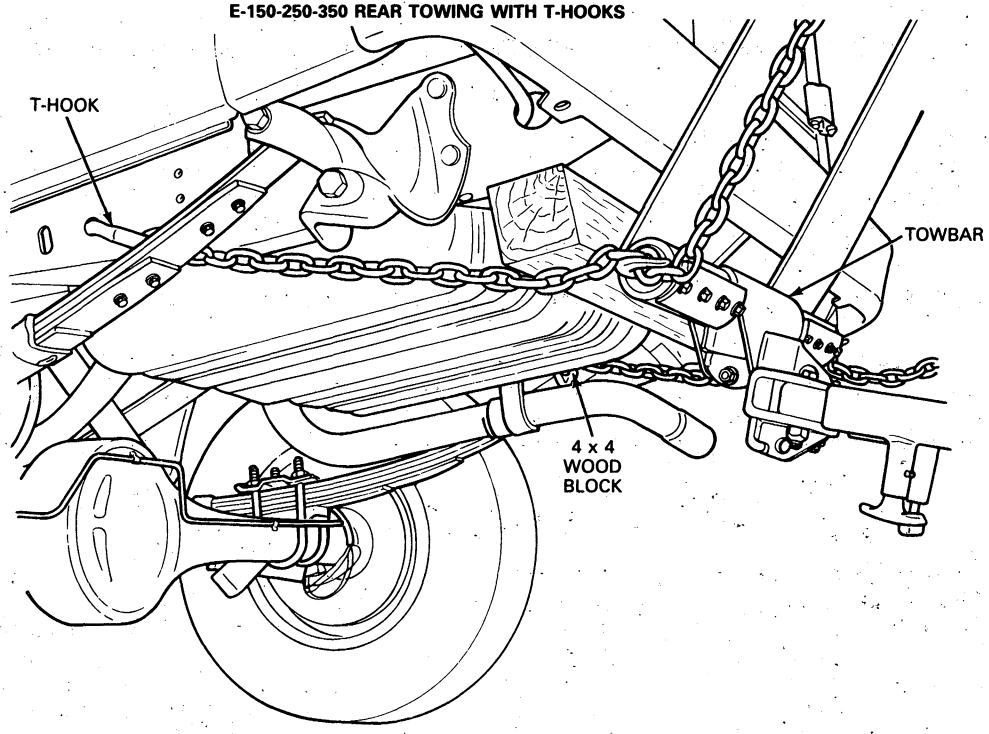
CAUTION: Do not use T-hooks on Econoline with 124 inch wheelbase.

1. Insert T-hook in angled T-hook slot in frame.
2. Position a 4x4 wood block across the frame rails ahead of the bumper. Position towbar against the 4x4 wood block rear face.

CAUTION: This hookup is designated to minimize the risk of bumper damage during normal towing. It is important that sling crossbar be tight against the 4x4 wood block lower rear face to minimize rear bumper tow load.

3. Attach safety chains around the frame rails or axle.

E-150-250-350 REAR TOWING WITH T-HOOKS



REAR TOWING – T-HOOKS – E-SERIES Y3109-2B

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GROUP 11 WHEELS AND TIRES

(1000 & 2000)

SECTION TITLE	PAGE
GENERAL WHEEL AND TIRE SERVICE	11-01-1
WHEEL HUBS AND BEARINGS—FRONT WHEEL DRIVE	11-12-1
WHEEL HUBS AND BEARINGS—REAR (SEMI-FLOATING AXLE)	11-11-1
WHEEL HUBS AND BEARINGS—REAR DANA FULL FLOATING AXLE	11-14-1
WHEELS, HUBS AND BEARINGS—FRONT (EXCEPT FRONT DRIVE)	11-10-1
WHEELS AND TIRES	11-02-1

SECTION 11-01 General Wheel and Tire Service

SUBJECT	PAGE
ADJUSTMENTS	
Front Wheel Bearing Maintenance	11-01-4
Wheel and Tire Checking Procedure	11-01-3
DIAGNOSIS AND TESTING	
Diagnosis Guides	11-01-3
MAINTENANCE	
Aluminum Wheels and Rims	11-01-9
Front Wheel Bearings	11-01-8
Rim and Wheel Maintenance	11-01-11
Safety Precautions	11-01-12
Tire Inflation	11-01-5
Tire Maintenance	11-01-5
Tire Rotation	11-01-8
Tread Wear Indicators	11-01-8
MAINTENANCE (Cont'd)	
Wheels	11-01-4
SAFETY	
Safety Precautions When Servicing Truck Tires	11-01-2
SERVICE	
Off-Vehicle Balancing	11-01-14
Tire and Wheel Balance	11-01-13
Tire Replacement	11-01-13
Tire Service	11-01-13
Vibration	11-01-14
SPECIFICATIONS	11-01-14
VEHICLE APPLICATION	11-01-1

VEHICLE APPLICATION

All E-150, 250 and 350, F-150, 250 and 350, F-Super Duty, F-Super Duty Stripped Chassis and Bronco Vehicles.

SAFETY

Wheels must be properly maintained because improperly maintained wheels and wheel components can adversely affect the life of the tire and the wheel. A tire when inflated is potentially very destructive. Accidents are caused by careless handling and inexperience. You must follow the safety procedures as outlined in this manual and obtain safety literature from your wheel and rim distributor, a wheel and rim manufacturer, NHTSA or OSHA. If you have any questions, consult the distributor or manufacturer directly. The load carrying requirements of each vehicle should also be determined before selecting the proper tire/wheel combination. Always remember that the weakest weight carrying component of the vehicle (i.e., tire, wheel, axle, bearings, etc.) determines its overall maximum and safe load carrying capacity for the vehicle.

WARNING: THE TIRE AND WHEEL MUST ALWAYS BE PROPERLY MATCHED. DO NOT MOUNT A 16 INCH TIRE ON A 16.5 INCH WHEEL. FAILURE TO STRICTLY ADHERE TO THESE IMPORTANT INSTRUCTIONS WILL RESULT IN AN EXPLOSIVE SEPARATION AND WILL CAUSE SERIOUS BODILY INJURY OR DEATH. IT IS VERY IMPORTANT TO DETERMINE THE SIZE OF EACH COMPONENT BEFORE ANY ASSEMBLY OPERATIONS COMMENCE.

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When replacing tires, use the same size, load range and construction type (bias, bias belted or radial) as originally installed on your vehicle. When replacing wheels, use original equipment manufacturers wheels or equivalent available from your Ford dealer with equivalent capacity, width, offset and mounting configuration as those originally installed on your vehicle. Use of improper replacement wheels and tires may adversely affect ride, handling, load carrying capacity, wheel bearing life, tire clearance to body and chassis components, vehicle ground clearance, vehicle width and brake cooling.

E-350, F-350, F-Super Duty and F-Super Duty stripped chassis vehicles equipped with dual wheel rear axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

Safety Precautions When Servicing Truck Tires

CAUTION AND SAFETY FIRST are important bywords when handling tires, **particularly truck tires.** Careful attention to the suggestions that follow may prevent crippling injuries, or even death. **Make it a rule to respect the terrific force contained in an inflated tire.** You may be glad some day that you did.

Prepare for any tire repair operation in a safe and efficient way. In changing tires on drop center wheels, remove the wheel and tire from the truck, **as changing tires with the wheel on the truck is hazardous, more difficult, and takes more time.** In servicing of all tires use caution not to drop them (or the wheels or assemblies) on the feet, hands or body, or heavily on the floor (Fig. 1). Practice good methods of lifting; use your legs as well as your arms and your body. This will help to prevent painful, internal injury. When carrying tires or wheels don't step in oil or grease. **Keep the floor clean and dry.**

Deflating a tire properly is very important to your safety. First, reduce the pressure as much as you possibly can by pushing the valve core plunger. **Only then should you remove the valve core.** Keep your eyes away from the valve: Fig. 2 shows the safe way to do it.

NOTE: If the tire is to be reinstalled on an original equipment wheel, mark the tire at the valve stem hole so that they can be reassembled in the same relative position.

Demounting tires from wheels or rims requires special care. Tires on drop center rims are best handled on a wheel holder, or tire-changing machine such as Rotunda Model 084-00001 or equivalent (Fig. 3).



FIG. 1 Handling Wheels and Tires



FIG. 2 Safe Air Removal

This can help prevent cuts on hands and wrists and will make it unnecessary to use a mallet for unseating the tire beads.

Use only standard tire mounting tools and equipment. The use of makeshift tools, screwdrivers or pliers to force tires on or off rims or wheels is dangerous.

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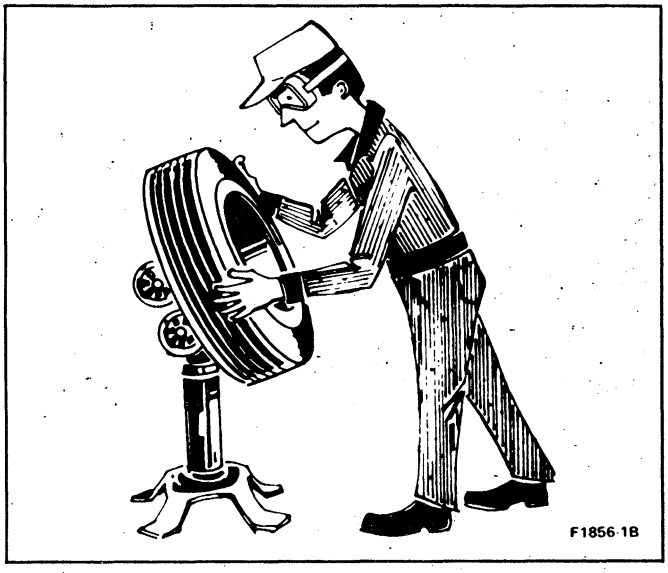


FIG. 3 Changing Tire on Drop Center Rim

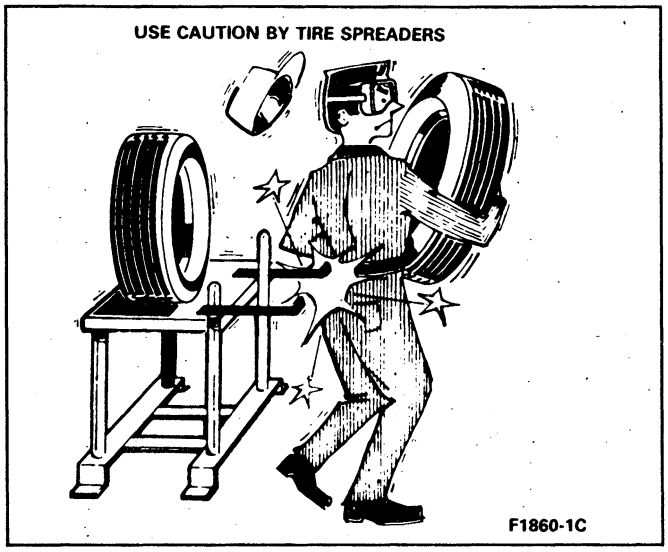


FIG. 4 Tire Spreader

Always lubricate tire beads to assure sealing of tire beads on rim with Rubber Lubricant D9AZ-19583-A (ESA-M1B6-A) or equivalent.

The Rotunda tire changer, 084-00001 or equivalent includes a bead seater/inflator using an automatically adjustable inflation ring, which aids in properly seating the bead for inflation. To properly operate the Rotunda tire changer, follow the instructions provided.

A careful inspection should be made of the tire and all necessary repairs should be performed. A tire spreader Rotunda Number 084-00002 is very helpful but use care when working around it. Keep the spreader arms closed when the machine is idle (Fig. 4).

Replace damaged or corroded parts. Abuse during road operations or in mounting tires can cause damage that may weaken the parts. Parts that are excessively corroded are weakened. Always inspect for and replace damaged or heavily rusted parts.

Inspect for and remove light rust and other foreign matter. Accumulation of such material on the engagement surfaces of the rim base and side can prevent the proper fit of these parts. Use of a rust preventative during mounting will minimize rust.

Tires and rims often require a buffing operation before being mounted once the regular repairs have been made.

Always wear safety goggles, or a face shield when performing any buffing operation.

Avoid hammering rims with steel hammers. Small bits of steel may be broken off the hammer or rim, flying into the eyes (wear safety goggles) face or body. Use rubber-covered, steel-headed hammers wherever possible. Rubber mallets only should be used on tires; although with modern tire changing equipment no pounding is necessary.

Stand away from the valve stem as far as possible while inflating tires. Avoid a position where the face or body is immediately over the work being done on any tire in which there is pressure.

Always use a safety cage, Rotunda 104-00104, or equivalent or portable safety device while inflating tires. Protect yourself from possible improper assembly, inadvertently mis-matched parts and other assembly errors. Remember that even the most experienced personnel can be careless on occasion and that an inflated tire contains potentially explosive energy.

Use only accurate, tested gauges to insure proper air pressure as specified on the Certification label attached to the vehicle. Check all gauges regularly with a master gauge.

The vehicle should not exceed the recommendations of load rating capacity specified on the vehicle safety certification decal (located on door pillar) relative to front and rear GAWR and vehicle GVWR.

Play it SAFE. Set a good example for others who work with you. Follow the above suggestions completely. **If you are ever tempted to take a short cut because you are in a hurry, that is the time that you could get hurt.**

Finally, always remember, a jack is provided for wheel and tire maintenance only. **Never run the engine when the vehicle is supported by a jack.**

DIAGNOSIS AND TESTING

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in wheel and tire service diagnosis.

ADJUSTMENTS

Wheel and Tire Checking Procedure

Inspect tires for wear from incorrect mounting misalignment, loose wheel bearings, bent wheels, or cupping or scalping from imbalance. Tires which show irregularities and definite roughness must be replaced.

Make certain that the brakes are not dragging and wheel bearings are properly adjusted before attempting to spin the wheels. On disc brakes, push the brake shoes into the caliper to free the rotor.

Vehicle Vibration Analysis Procedure

1. Initial Checks:
   a. Tire Matching—Tire size and type match.
   b. Inflation Pressure—Correct inflation pressure.

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c. Appearance—Check for wear and condition of tires and wheels.

d. Rim Centering—Check that tire beads are properly seated.

2. Problem Definition:

a. Ask customer to explain the problem.

b. Ride in vehicle and experience the vibration described by owner (with owner if possible). Note speed and suspect wheel position.

3. Tire Runout Check on Vehicle:

a. Runout okay—Go to dynamic balance check.

b. Excessive runout—Refer to match mounting procedure.

c. High runout still present—Refer to wheel stud runout procedure.

d. Replace high runout wheels or tires when required—Go to dynamic balance check.

4. Dynamic Balance:

Mark a stud bolt and the corresponding position on the rim to ensure that the assembly can be replaced on the vehicle in its original position. Do not remove existing balance weights. If rebalance only requires 1/2 oz. or less on either flange, the problem is not imbalance; proceed to ride test.

If problem is balance, rebalance and continue to ride test.

Never add more than 3 oz. of weight per flange on a passenger car tire. If more weight is required:

a. Spin the assembly on the balancer in static mode.

b. Mark the location and amount of weight required on the sidewall. Do not balance assembly.

c. Remove assembly from the balancer, deflate and rotate tire halfway around (180 degrees) as in matching for runout.

d. Reinflate, replace on balancer and respin a second time in static mode.

e. Mark location and amount of weight required on sidewall.

f. If your two marks are within 4 inches of each other, it is the tire that is the major contributor to imbalance. (The marks followed the tire when it was rotated.) Replace tire.

g. If your two marks are within 4 inches of being opposite each other on the tire, then the wheel is out of balance. Replace wheel.

h. If the two marks are neither opposite nor together, then the assembly can be match mounted for static balance. Refer to match mounting procedure.

5. Ride Test:

a. Problem eliminated—Stop.

b. Vibration is still present check:

Brake drum imbalance

Engine or transmission mounts

Excessive drive shaft runout or imbalance

Improper pinion angle

Faulty universal joints

Worn or damaged wheel bearings

Brake rotor imbalance

Match Mounting Tires

Match mounting is a technique used to reduce radial or lateral tire runouts on tire and wheel assemblies. Excessive runout is a source of ride complaints and match mounting can be used to minimize the runout. There are two ways to use match mounting: 1. positioning of the tire on the wheel; and 2. positioning the wheel on the hub.

1. Measure the total indicated runout on the center of the tire tread rib, and record it. Mark the tire and rim at the center of the tread rib, and record the reading. Mark the tire at the location of the valve stem for reference.

2. Break down the tire and remount it 180 degrees on the rim so that the valve stem reference mark is opposite of the valve stem on the wheel.

3. Reinflate the tire and measure the total indicated runout, and again mark the high spot.

4. If the runout is reduced to acceptable guidelines the tire is ready to be put back into service. If the runout is still excessive, one of the following steps must be performed:

- If the high spot is within 4 inches of the first high spot on the tire, and is still outside of guidelines, replace the tire.
- If the high spot is within 4 inches of the first high spot on the wheel, the wheel may be out of tolerance, check the wheel for runout.
- If the high spot is not within 4 inches of either original high spot of the tire and rim, then draw an arrow from the second high spot to the first high spot (in the shortest direction) and rotate the tire on the rim 90 degrees in that direction. This will normally reduce the runout to an acceptable level.

In the majority of cases, the first 180 degrees turn of the tire will either fix the problem or indicate which item to replace.

Front Wheel Bearing Maintenance

Wheel bearings are adjustable. Satisfactory operation and long life of bearings depend on proper adjustment and correct lubrication. **If bearings are adjusted too tightly, they will overheat and wear rapidly. An adjustment that is excessively loose can cause pounding and contribute to uneven tire wear, steering difficulties and inefficient brakes. The bearing adjustment should be checked at regular inspection intervals.**

For Front wheel bearing adjustment procedures, refer to Section 11-10, Wheel Hubs and Bearings-Front (except Front drive) and Section 11-12, Wheel Hubs and Bearings-Front Wheel Drive.

MAINTENANCE

Wheels

Wheel lug nuts should be inspected and tightened twice within the first 800 kilometers (500 miles) of operation. After the first 1600 Kilometers (1000 miles) of operation, they should again be inspected and tightened at the intervals specified by Section 10-02, Maintenance. Also retighten to specifications at 800 km

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Tires show excess wear on edge of tread.	1. Under inflated tires. 2. Vehicle overloaded. 3. High-speed cornering. 4. Incorrect toe setting.	1. Adjust air pressure in tires. 2. Correct as required. 3. Correct as required. 4. Set toe to specification.
Tires show excess wear in center of tread.	1. Tires over inflated.	1. Adjust air pressure in tires.
Other excessive tire wear problems.	1. Improper tire pressure. 2. Incorrect tire/wheel usage. 3. Loose or leaking shock absorbers. 4. Front end out of alignment. 5. Front wheel bearings out of adjustment. 6. Loose, worn or damaged suspension components, bushings and ball joints. 7. Wheels and tires out of balance. 8. Excessive lateral and/or radial runout of wheel or tire. 9. Tires need rotating.	1. Adjust air pressure in tires. 2. Install correct tire and wheel combination. 3. Tighten or replace as necessary. 4. Align front end. 5. Adjust front wheel bearings. 6. Inspect, repair or replace as required. 7. Balance wheels and tires. 8. Check, repair or replace as required. Use dial indicator to accurately determine runout. 9. Rotate tires.
Wheel mounting is difficult.	1. Improper application or mismatched parts, including studs and nuts. 2. Corroded or worn parts.	1. Follow manufacturers' specifications. 2. Clean or replace.
Wheel-rust or corrosion.	1. Poor maintenance.	1. Keep clean and protect with paint.

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(500 miles) after any wheel change or any other time the lug nuts have been loosened. Improperly tightened wheel nuts could allow the wheel to come off while the vehicle is in motion, causing loss of control. Loose wheel stud nuts may cause shimmy stud damage and/or stud failure, possible wheel damage, and vibration. Elongated stud holes in the wheels may also result from the loose stud nuts.

For vehicles equipped with dual rear wheels, tighten wheel lug nuts to specifications after 160 km (100 miles) and again after 800 km (500 miles) of new vehicle operation, and at the intervals specified in the maintenance section, according to the Wheel Removal and Installation instructions in Section 11-02, Wheels and Tires. This is required to permit the wheel clamping system to seat properly so that the wheel lug nuts will hold a uniform clamp load and remain fully tightened. Retightening to specification is also required at 800 km (500 miles) after any wheel change and any other time the lug nuts have been loosened. Improperly tightened wheel lug nuts could allow the wheel to come off while the vehicle is in motion, causing loss of control.

Keep the wheels and hubs clean. Stones or lumps of mud wedged between the wheel and drum will unbalance a wheel and tire.

Check for damage that would affect the runout of the wheels. Wobble or shimmy caused by a damaged wheel will eventually damage the wheel bearings and cause uneven tire wear. Inspect the wheel rims for dents that could permit air to leak from the tires.

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH YOUR VEHICLE AND SHOULD NOT BE USED. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE INJURY. ONLY WHEEL ASSEMBLIES APPROVED FOR VEHICLE APPLICATION SHOULD BE USED.

Tire Maintenance

Refer to Fig. 5.

To maximize tire performance, inspect them for signs of improper inflation and uneven wear, which may indicate a need for balancing, rotation, or front suspension alignment. Tires should also be checked frequently for cuts, stone bruises, abrasions, blisters, and for objects that may have become imbedded in the tread. More frequent inspections are recommended when rapid or extreme temperature changes occur, or where road surfaces are rough or occasionally littered with debris.

As a further visible check of tire condition, tread wear indicators are molded into the bottom of the tread grooves. The tire should be replaced when these indicator bends become visible.

To clean tires, use a mild soap and water solution only, and rinse thoroughly with clear water. Do not use any caustic solutions or abrasive materials. Do not use steel wool, wire brushes or gasoline, paint thinner and similar materials having a mineral oil base. These materials are harmful to the tires and will eventually discolor the whitewalls and raised letters.

Tire Inflation

The tire inflation pressure is carefully calculated to give the vehicle satisfactory ride and steering characteristics while not compromising long tire tread life.

There is a tire chart (refer to Owner's Guide for location or refer to the chart in the Specifications

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Excessive vehicle vibration, rough steering, or severe tire wear.	1. Loose or improper attaching parts.	1. Tighten or replace.
	2. Overloading or unbalanced loads.	2. Check wheel and tire specs against work load requirements. Recommend correct tire and rim. Check on loading procedure.
Vehicle vibrations.	1. Tires/wheels mismatched.	1. Install correct tire/wheel combination.
	2. Inflation pressure too high or low.	2. Adjust air pressure in tires.
	3. Uneven tire wear.	3. Refer to Tire Wear Conditions Chart.
	4. Out-of-balance wheel and/or tire or hub and drum assembly.	4. Determine the out-of-balance component and balance or replace.
	5. Bent or distorted wheel disc from overloading, road impact hazards or improper handling.	5. Replace wheel. Attempts to straighten wheel can result in fractures in the steel and weakening of the disc or the weld between disc and rim. Check loading and operating conditions and shop practices.
	6. Out-of-round wheel or tire (excessive radial runout). Use a dial indicator to accurately verify runout reading.	6. Replace the wheel or tire and check for overloading and unbalanced loads, rugged operating conditions, proper wheel and tire specifications.
	7. Improperly seated bead.	7. Verify correct tire/wheel usage and re-mount tire.
	8. Excessive lateral runout (wheel or tire). Use a dial indicator to accurately verify runout reading.	8. Replace wheel or tire.
	9. Loose wheel mountings — damaged studs, cap nuts, enlarged stud holes, worn or broken hub face or foreign material on mounting surfaces.	9. Tighten and/or replace worn or damaged parts. Clean mounting surfaces.
	10. Defective wheel bearings.	10. Replace defective bearing sets.
	11. Brake rotor imbalance.	11. Check for uneven rotor wear. If present, true both rotors. Check fins for caked mud or debris. If no external causes are evident, rotor may have a heavy spot. To confirm, substitute a known-good rotor or shift rotor to other side of vehicle and road test again. If heavy spot is indicated, replace rotor.
	12. Wheel stud runout.	12. Replace hub or axle shaft.
	13. Water in tires.	13. Remove water.
	14. Loose or worn engine or transmission mounts.	14. Tighten or replace.
	15. Improper pinion angle.	15. Realign assembly to specifications. If damaged, replace pinion and ring gear as a set.
	16. Improper front end alignment.	16. Align front end.
	17. Loose or worn driveline or suspension parts.	17. Identify location of vibration carefully as it may be transmitted through frame making a rear end vibration appear to come from the front. Repair or replace loose and worn parts.
	18. Excessive drive shaft runout or imbalance.	18. Balance or replace drive shaft as necessary.
	19. Faulty U-Joints.	19. Replace worn U-Joints.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Cracked or broken wheel discs. Cracks develop in the wheel disc from hand hole to hand hole, from hand hole to rim, or from hand hole to stud. Stud holes become worn, elongated or deformed. Metal builds up around stud hole edges, cracks develop from stud hole to stud hole. Related driver complaints: unusual operating noise or vibration and on the road failures.	1. Metal fatigue resulting from abusive handling.	1. Replace wheel. Check position of wheel on vehicle for working load specifications.
	2. Truck operated with loose wheel mounting.	2. Replace wheel and check for: — Installation of correct studs and nuts, and recommend exact specifications. — Cracked or broken studs, and replace. — Worn hub face. Machine if not excessive, or replace if severe. — Broken or cracked hub barrel, replace. — Worn stud grooves, replace or install recommended serrated bolts. — Clean mounting surfaces and re-torque cap nuts periodically. — Rust streaks fanning out from stud holes are a sure indication that the cap nuts are or have been loose.
Cracks develop in rim base back (rim bead seat) or the gutter area (drop well radii).	1. Overloading or abusive use.	1. Replace wheel. Check loading and operating conditions. Avoid over inflation of tires. Check specs for rim load capacity, working loads, tire size, ply rating and tire construction.
	2. Improper use of tools.	2. Check mounting, demounting, and maintenance procedures.
Dual tires rubbing (kissing).	1. Insufficient wheel spacing.	1. Check tire and wheel sizes. Make certain proper size tire and wheels are used.
	2. Overloading.	2. Reduce weight.
Damaged stud threads.	1. Sliding wheel across studs during assembly.	1. Replace studs. Follow proper wheel installation procedure.
Loose drum.	1. Stud too long.	1. Replace stud with proper length stud.
Loose inner wheel.	1. Excessive stud standout from mounting face of hub permitting wheel nut to bottom out.	1. Replace stud with proper length stud.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Broken studs.	1. Loose lug nuts.	1. Replace studs. Follow proper torque procedure.
	2. Overloading.	2. Replace studs. Compare actual load against vehicle load ratings.
Stripping threads.	1. Excessive torque.	1. Replace studs. Follow proper torque procedure.
Rust streaks from stud holes.	1. Loose lug nuts.	1. Check complete assembly. Replace damaged parts. Follow proper torque procedure.
Damaged lug nuts.	1. Loose wheel assembly.	1. Replace lug nuts. Follow proper torque procedure.
	2. Overtightened lug nuts.	
Frozen lug nuts.	1. Corrosion or galling.	1. If corrosion is slight, wire brush away corrosion. If corrosion is excessive, replace studs and nuts. If condition persists, lubricate first three threads of each stud with a graphite-based lubricant. **CAUTION:** Do not permit lubricant to get on ball seats of stud holes or on ball face of lug nuts.
	2. Overloading.	2. Reduce weight.

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position of this section) that gives the recommended cold tire inflation pressure. Tire inflation pressures are also listed at the end of this Section under Specifications. The cold tire inflation pressure can be measured after the vehicle has been parked for three hours or has been driven less than 5 km (3 miles).

A higher tire inflation pressure than the recommended pressure can cause a hard ride, tire bruising, carcass damage, and rapid wear at the center of the tire. Low tire pressure can produce tire squeal, hard steering, rim dents, high temperatures, and rapid wear on the outer edges of the tires. Unequal inflation pressures in tires using the same axle can affect uneven braking and reduced handling.

CAUTION: Over- or under-inflated tires can reduce tire life, adversely affect vehicle handling, and possibly lead to a sudden failure that could result in the loss of vehicle control without warning.

Tire Rotation

To equalize tire wear, tires may be rotated, but not until the cause of unusual or uneven tire wear is determined and corrected (Fig. 6). Rotation is recommended at 8000-16000 km (5,000-10,000 miles) intervals.

Tread Wear Indicators

The original equipment tires have built-in tread wear indicators to show when tires need replacement. These indicators will appear as 1/2 inch wide bands when the tire tread depth becomes 1/16 of an inch (Fig. 7). When the indicators appear in two or more adjacent grooves, at three locations around the tire, or when cord or fabric is exposed, tire replacement due to tread wear is required.

Front Wheel Bearings

Wheel bearings are adjustable. Satisfactory operation and long life of bearings depend on proper adjustment and correct lubrication. **If bearings are adjusted too tightly, they will overheat and wear rapidly. An adjustment that is excessively loose can cause pounding and contribute to uneven tire wear, steering difficulties and inefficient brakes. The bearing adjustment should be checked at regular inspection intervals.**

Front hub assemblies and bearings should be cleaned, inspected and lubricated whenever the hub assemblies are removed or at the mileage/time periods indicated in the maintenance schedule.

New hub assembly grease seals should be installed when the hub is removed. A damaged or worn seal may permit bearing lubricant to reach the brake linings, resulting in ineffective brake operation and necessitating premature replacement of linings.

Bearing adjustment is described in Section 11-10 Wheel Hubs and Bearings—Front (except Front Drive) for front wheels. Section 11-12 Wheel Hubs and Bearings—Front Wheel Drive covers front drive bearing adjustment. Section 11-14 Wheel Hubs and Bearings—Rear (Full Floating Axle) cover rear wheel bearing adjustments.

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TIRE/WHEEL CONDITIONS

TEST STEP	RESULT ▶	ACTION TO TAKE
NOTE: On vehicles equipped with all terrain type tires, a vibrating, drumming or beating noise is often misdiagnosed as a driveline vibration. Replace the all terrain type tires with the specified highway type tires. If condition is eliminated, refer to Section 18-01, Noise Vibration and Harshness. If condition is still present, refer to the procedure below.		
1 EXCESSIVE WEAR OR CUPPING • Check tires for excessive wear or cupping.	(OK) ▶ (OK) ▶	GO to **2**. REPLACE severely worn tires. CHECK tire inflation, vehicle alignment and suspension. REPAIR, REPLACE or ADJUST as required. GO to **2**.
2 WHEEL BEARING ENDPLAY • Check wheel bearing endplay. • Rotate wheel and check for roughness.	(OK) ▶ (OK) ▶	GO to **3**. REPLACE wheel bearings, if required. ADJUST to correct endplay. ROAD TEST to verify correction.
3 TIRE WHEEL BALANCE • Check tire/wheel balance, using Dynamic Balance procedures outlined in Section 18-01.	(OK) ▶ (OK) ▶	GO to **4**. BALANCE tire/wheel assembly. If assembly cannot be balanced, REPLACE wheel and/or tire. ROAD TEST to verify correction.
4 REINDEX TIRE • Reindex tire 180 degrees and rebalance on wheel.	(OK) ▶ (OK) ▶	ROAD TEST to verify correction. GO to **5**.

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Aluminum Wheels and Rims

Cleaning

Whenever a tire is removed, thoroughly examine the complete wheel. Remove all grease and road dirt and use a wire brush or steel wool to remove the rubber from the bead seat.

Straightening Wheels

Do not heat wheels in an attempt to soften them for straightening to repair damage from striking curbs, etc. The special alloy used in these wheels is heat-treated, and uncontrolled heating from welding affects the properties of the material. Do not weld the wheels for any reason.

Valves

Wheels for tubeless tires come from the factory with air valve installed. If it becomes necessary to replace an air valve it should be installed using 19 N·m (14 ft-lbs) of torque on the hex nut.

Maintenance and Protection in Corrosive Environments

Due to aluminum's natural resistance to corrosion, aluminum forged or cast wheels do not need to be repainted for most operating conditions. Washing them

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TIRE/WHEEL CONDITIONS (Continued)

TEST STEP		RESULT ▶	ACTION TO TAKE
5	TIRE RUNOUT		
	• Check tire runout.	(OK) ▶	GO to 7.
		(OK) ▶	GO to 6.
6	WHEEL STUD RUNOUT		
	• Check wheel stud runout.	(OK) ▶	GO to 7.
		(OK) ▶	REPLACE hub or axle shaft. ROAD TEST to verify correction.
7	ALIGNMENT, SUSPENSION, DRIVELINE, BRAKES, ENGINE/TRANSMISSION MOUNTS		
	• Check front end alignment if not done during Step 1. • Check suspension components for looseness or wear if not done during Step 1. • Check U-Joint condition. • Check driveshaft for runout or imbalance. • Check drums/rotors for imbalance. • Check engine and transmission mounts for looseness or wear.	(OK) ▶	GO to 8.
		(OK) ▶	REPAIR, REPLACE, OR ADJUST as required. ROAD TEST to verify correction.
8	WHEEL RUNOUT		
	• Check wheel runout.	(OK) ▶	REPLACE tire. ROAD TEST to verify correction.
		(OK) ▶	REPLACE wheel and rebalance. ROAD TEST to verify correction.

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(do not use highly alkaline cleaning agents) when washing the rest of the vehicle will be enough to keep wheels looking good for many years. Certain environments, as created by some operations, can lead to corrosion. Some of these are: livestock hauling, salt, chloride compounds used for snow removal and highly alkaline materials. When these conditions are encountered, the following practice is recommended:

1. Clean frequently with steam or high-pressure water from a hose. Use of a mild detergent will speed up the cleaning process.
2. When tires are removed, the entire wheel should be cleaned and inspected. For maximum protection, there are various types of coatings which give good results. The following procedures are suggested:

Surface Preparation

1. Remove all the soil and oil from the wheel surface with either high-pressure steam or solvent. Suitable solvents would be mineral spirits and regular paint thinner, obtained in paint stores.
2. Remove any adherent soil or oxidation products by using a wire brush.
3. Clean the surface again with solvent, using mineral spirits to remove loose products.
4. Apply a clear protective or pigmented product as follows:

Clear Protective Coating

Spray apply about 1 1/2 to 2 mils wet film thickness, air curing clear epoxy polyamide meeting Military Specification MIL-C-22750 (WEP) or equivalent. To properly spray this particular coating, mix components A and B of the two-part organic coating and thin where necessary with 10 percent toluol. Spray apply with a spray gun at a pressure of 207-276 kPa (30-40 psi) (suction feed).

Pigmented Protective Coating

Primer-Spray apply the inhibited primer, meeting Military Specification MIL-C-23377 (SEP) or equivalent. Spray this primer at a 1 to 2 mil wet film thickness. Allow to air dry from 2 to 4 hours before top-coating.

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TIRE/WHEEL CONDITIONS — NOISE OR VIBRATION — 4x4 VEHICLES ONLY

TEST STEP	RESULT	ACTION TO TAKE
1 VERIFY CONDITION Verify the condition by road-testing the vehicle. **NOTE: Verify the condition by driving the vehicle with known quality conventional tires.**	Condition disappears (OK) ▶	SERVICE or REPLACE tires as described in the appropriate portion of Section 11-01, General Wheel and Tire Service
	Condition still exists (OK) ▶	GO to **2**
2 REMOVE FRONT DRIVESHAFT Unlock the front hubs and remove the front driveshaft. Place the transfer case in the two-wheel drive position (2H) and road test the vehicle.	Condition disappears (OK) ▶	SERVICE the front driveshaft or front drive axle as described in the appropriate section of this manual.
	Condition still exists (OK) ▶	GO to **3**
3 REMOVE REAR DRIVESHAFT Reinstall the front driveshaft. Lock the front hubs and remove the rear driveshaft. Place the transfer case in 4-high (4H), the four-wheel drive position. Road test the vehicle.	Condition disappears (OK) ▶	SERVICE the rear driveshaft or rear axle as described in the appropriate section of this manual.
	Condition still exists (OK) ▶	REFER to driveline diagnosis in Section 15-01, General Driving Axle and Driveshaft Service.
NOTE: Tire and wheel conditions, refer to the procedures found in Section 11-01, General Wheel and Tire Service.		

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Top Coat-Spray a 1 1/2 to 2 mils wet film of a leafing aluminum pigmented epoxy. Allow enough time to air dry before handling; overnight will usually be sufficient.

Rim and Wheel Maintenance

During Tire Inspections

1. Check all metal surfaces thoroughly while making tire inspections, including areas between duals and on inboard side of wheel. Watch for:
   - excessive rust or corrosion build-up
   - cracks in metal
   - bent flanges, resulting from road obstructions
   - loose, missing or damaged nuts
   - bent or stripped studs
2. Remove damaged rims or wheels.

   CAUTION: Excessively corroded or cracked rims can be dangerous. Deflate tires prior to the removal from the wheels.
3. Mark damaged or hazardous areas with chalk so that part will be removed from service.
4. Replace parts as required.
5. Inflate tires only to recommended air pressures.
6. Check the wheel lug nut torque and retighten the lug nuts as specified at the end of this Section.

During Tire Changes

1. Check all metal surfaces. Watch particularly for the following items:
   - Cracks in the rim bead seat or drop well radii areas. These are caused by deep rim tool marks, overloading and overinflating tires or using larger than recommended tire sizes.
   - Cracks in the wheel disc, between the stud holes or hand holes. These are caused by loose wheel nuts, improper installation procedures or the use of incorrect sizes or types of attaching parts.
2. Replace the parts as necessary.

   CAUTION: Insure that replacements are made with the proper sizes and types of wheels.
3. Thoroughly remove rust, dirt and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used. Bead seat areas of rim should be free of rust and rubber deposits. This is especially important

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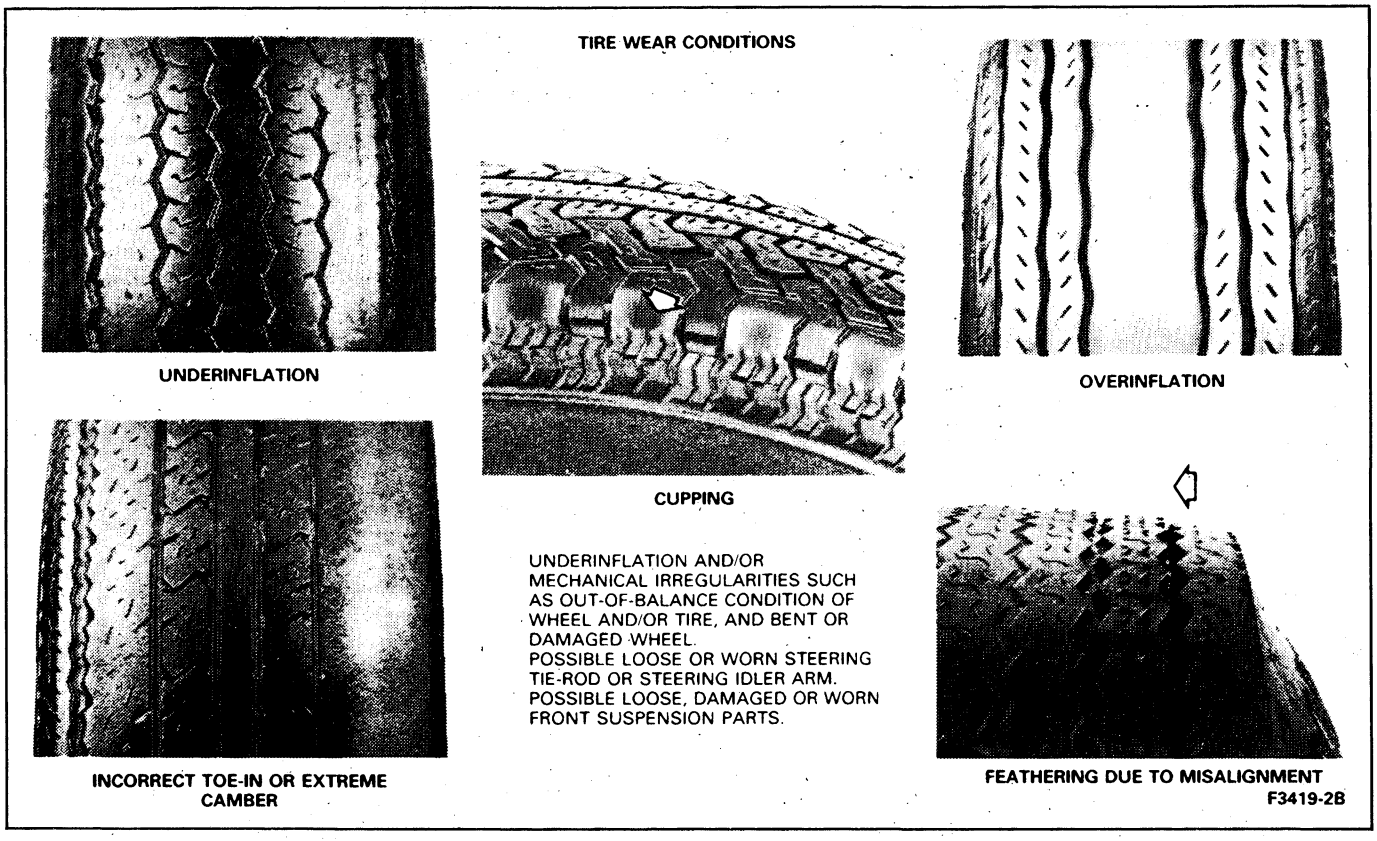


FIG. 5 Tire Wear Conditions

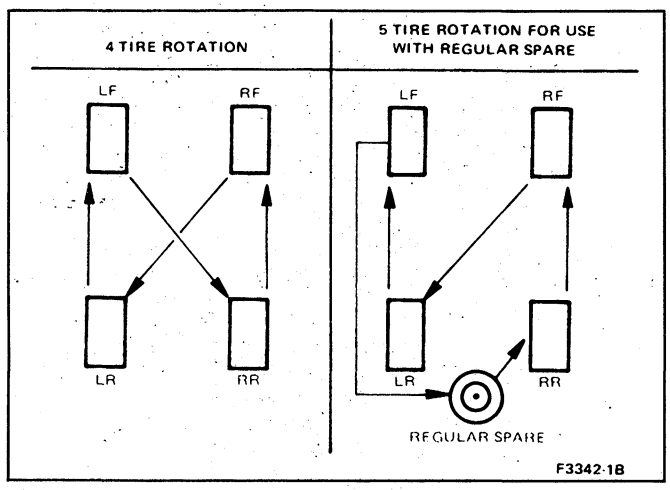


FIG. 6 Tire Rotation Patterns

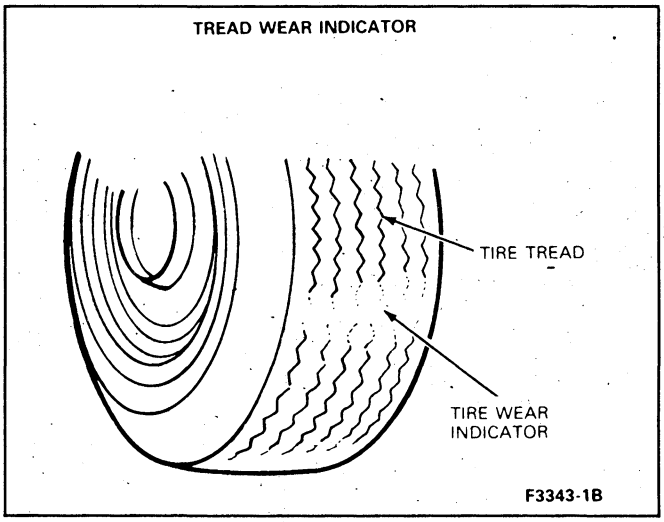


FIG. 7 Tread Wear Indicator

for drop-center tubeless rims, because the bead seat is the air-sealing element.

4. Paint rim by brush or spray with a fast-drying metal primer. Surfaces should be clean and dry prior to painting. Insure that bare metal areas on the outside or tire side of rim are covered. This is especially important on drop-center tubeless rims, because warm and sometimes moist air is in constant contact with the metal surface on the tire side of the rim.

5. Lubricate the tire side of the rim base just prior to mounting tire. Avoid the use of any lubricant which contains water or solvent that is injurious to rubber. A combination lubricant and rust-preventive compound is preferable. This protective measure is of particular importance with drop-center tubeless rims as the air in the tire is contained by the tire-side rim surface.

6. Inflate tire to recommended air pressure.

Safety Precautions

Air tank should incorporate moisture trap when used with drop-center tubeless rims in order to reduce the moisture in contact with the metal rim surfaces.

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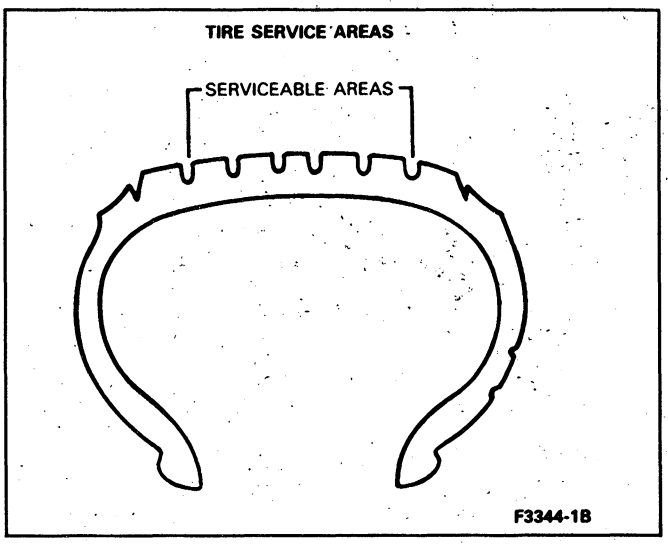


FIG. 8 Tire Service Area

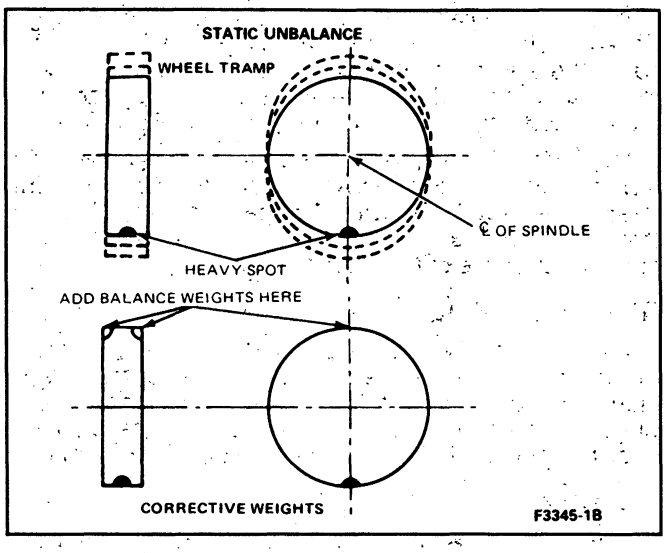


FIG. 9 Static Unbalance

SERVICE

Tire Replacement

NOTE: When a tire is replaced, use only a tire and wheel combination as recommended on the Safety Compliance Certification Label decal attached to the vehicle. Be sure that all tires and wheels are approved by Ford Motor Company and are of the same size and load carrying capacity. Never mix radial, bias or bias belted type tires.

Use the Rotunda Tire Changer 084-00001 or equivalent to mount or demount tires. Follow the equipment manufacturer's instructions. Do not use hand tools or tire irons alone to change tire because they may damage the tire beads or wheel rim.

Rim bead seats (steel wheels only) should be cleaned with a wire brush or coarse steel wool to remove lubricants, old rubber, and light rust. Aluminum wheel rim bead seats should be cleaned with a non-abrasive cleaner to remove tire mounting lubricants and old rubber. Before mounting or demounting a tire, the bead area should be well lubricated with Rubber Lubricant, D9AZ-19583-A (ESA-M1B6-A) or equivalent tire lubricant.

After initial mounting, inflate the tire, so its beads are completely seated. **CAUTION: Do not inflate to more than 276 kPa (40 psi), then, deflate tire.** Install the valve core, and inflate the tire to the proper pressure shown on the Safety Certification Label. Balance each wheel and tire assembly.

Tire Service

NOTE: If the tire is to be reinstalled on the same wheel, mark the tire and wheel so they can be reassembled in the same position.

Punctured tires should be removed from the wheel and permanently serviced from the inside using a combination repair plug and vulcanized patch. When servicing a puncture, always follow the manufacturer's instructions for using the service kit.

Punctures in the tread area only are serviceable (Fig. 8). Never attempt to service punctures in the tire shoulders or sidewalls. In addition, do not service any tire that has sustained the following damage:

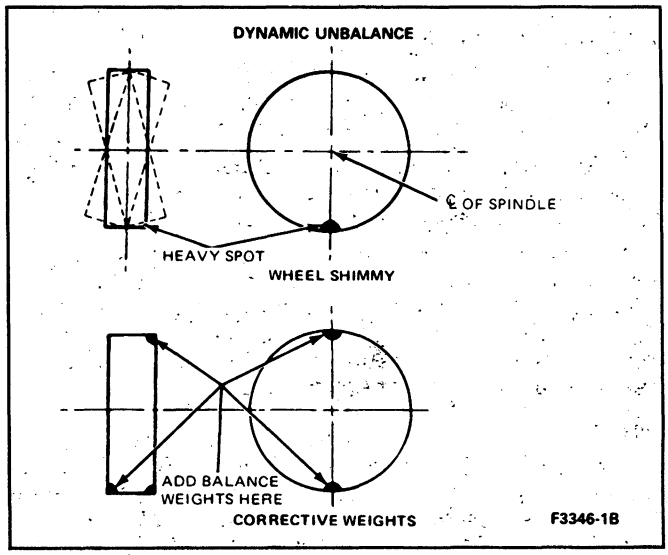


FIG. 10 Dynamic Unbalance

- Bulges or blisters.
- Ply separation.
- Broken or cracked beads.
- Fabric cracks or cuts.
- Tires worn to the fabric, or if wear indicators are visible.
- Punctures larger than 1/4 inch diameter.

WARNING: TIRE SEALANTS THAT ARE INJECTED THROUGH THE VALVE STEM ARE NOT TO BE USED TO SERVICE PUNCTURED TIRES BECAUSE THEY CAN PRODUCE WHEEL RUST AND TIRE IMBALANCE.

Tire and Wheel Balance

There are two types of wheel and tire balance: static and dynamic.

A static balance is the equal distribution of weight around the wheel. Wheels that are statically unbalanced cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear (Fig. 9).

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A dynamic balance is the equal distribution of weight on each side of the centerline, so that when the tire spins there is no tendency for the assembly to move from side to side. Wheels that are dynamically unbalanced may cause wheel shimmy (Fig. 10).

Deposits of mud, etc. must be cleaned from the inside of the rim. Stones should be removed from the tread. The tire should be inspected for any damage, then balanced according to the equipment manufacturer's explicit instructions.

Off-Vehicle Balancing

When balancing wheels off the vehicle, use a balancer which pilots the wheels by the center hole or mounting bolt holes. If the wheel tramp and vehicle vibration is not corrected by the off-vehicle balance, refer to Section 18-01, Noise, Vibration and Harshness.

Vibration

If vehicle vibration persists after the wheels have been balanced, it may be caused by either tire, wheel or wheel bolt runout.

Tire and Wheel Runout

Excessive radial and lateral runout of a wheel and tire assembly can cause roughness, vibration, wheel tramp, tire wear, and steering wheel tremor.

Before checking runout and to avoid false readings caused by temporary flat spots in the tires, check runout only after the vehicle has been driven.

The extent of the runout should be measured with Radial Runout Gauge Rotunda 007-00014, or equivalent. All measurements should be made on the vehicle with the tires inflated to recommended reduced load inflation pressures and with the front wheel bearings adjusted to specifications.

Tire Runout

Measure radial runout, using Rotunda Radial Runout Gauge 007-00014 or equivalent, of the tire at the center and outside ribs of the tread face (Fig. 11). Measure lateral runout of the tire just above the buffing rib on the tire sidewall (Fig. 11). Mark the high points of lateral and

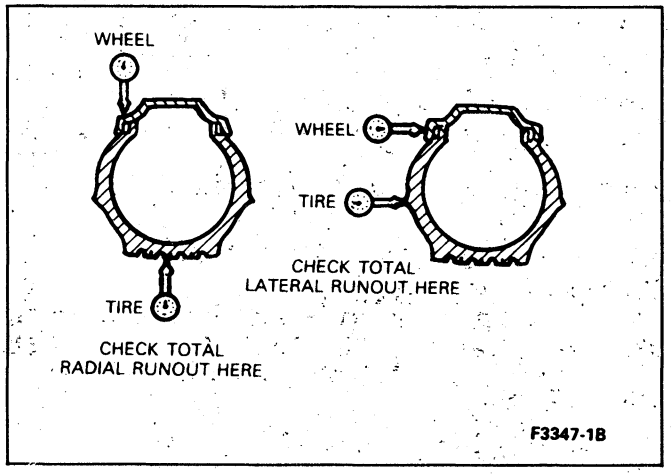


FIG. 11 Radial and Lateral Runout Checks

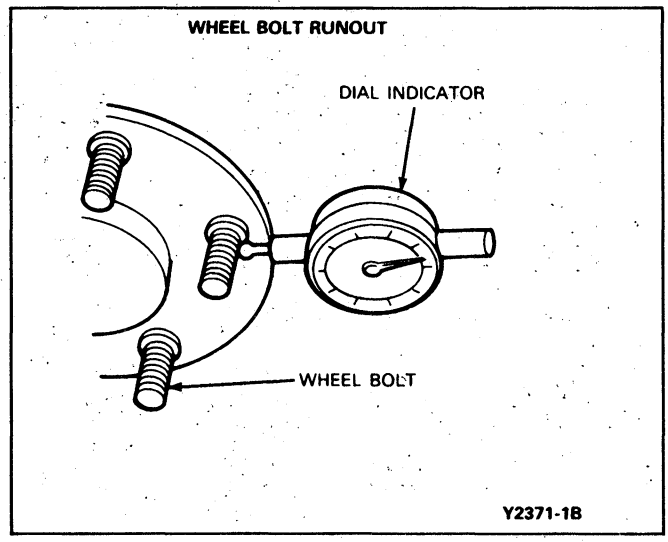


FIG. 12 Measuring Wheel Bolt Runout

radial runout for future reference. On tires, radial runout should not exceed 0.040 inch, and lateral runout should not be more than 0.045 inch.

Wheel Runout

Measure radial and lateral wheel runout at the positions shown in Figure 11. Runout should not exceed .045 inches in either position.

Wheel Bolt Runout

Wheel bolt runout can affect wheel runout. When measuring the runout on the wheel bolts, it should be noted that the feeler will not be in contact with the bolts at all times. Only the measurements taken at the high point of contact of each bolt should be considered.

1. Using a broad point indicator, locate the feeler perpendicular to the bolt (Fig. 12), as close to the flange face as possible. Be careful to zero the indicator so that the pointer can deflect either way, thereby insuring an accurate reading at the lowest as well as the highest contact point.
2. Rotate the shaft until the next bolt is contacted. Again, record and continue until you have one reading for each point of contact (each bolt). The absolute difference between the maximum and minimum contact reading will be the total indicator reading (or total runout). Wheel bolt circle runout should not exceed .41mm (0.016 inch) TIR (Total Indicated Runout).

SPECIFICATIONS

ROTUNDA EQUIPMENT

Number	Description
084-00001	Truck Tire Changer
084-00002	Tire Spreader
007-00014	Radial Runout Gauge
104-00104	Inflation Chamber

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WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty and F-Super Duty Stripped Chassis Vehicles	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2E

Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
F-150 (4x2) RC, SWB	117 inch (2967 mm)	5250	15 x 6.0JK*	P215/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	35	41	241	283
F-150 (4x2) RC, LWB	133 inch (3378 mm)	5450	15 x 6.0JK*	P215/75R 15SL	35	35	241	241
		6250	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x2) SC, SWB	139 inch (3526 mm)	6050	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x2) SC, LWB	155 inch (3937 mm)	6250	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x4) RC, SWB	117 inch (2967 mm)	6100	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x4) RC, LWB	133 inch (3376 mm)	6250	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
			15 x 6.0JK①	P235/75R 15XL	38	41	262	283
F-150 (4x4) SC, SWB	139 inch (3526 mm)	6250	15 x 6.0JK	P235/75R 15XL	35	41	241	283
F-150 (4x4) SC, LWB	155 inch (3937 mm)	6250	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
Bronco	105 inch (2660 mm)	6000/6300	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
			15 x 8.0JJ	31-10.5RX 15C	40	40	276	276
		6450	15 x 6.0JK*①②	P235/75R 15XL	38	41	262	283
			15 x 8.0JJ①②	31-10.5RX 15C	40	40	276	276
F-250 (4x2) RC	133 inch (3378 mm)	6600	16 x 6K	LT215/85R 16D	51	51	352	352
			16 x 6K	LT235/85R 16D	44	44	303	303
			16 x 6K	LT235/85R 16E	44	44	303	303
			16 x 6K	7.50R-16D	40	50	276	345
		7700	16 x 6K*	LT235/85R 16D	44	65	303	448
			16 x 6K	LT235/85R 16E	44	65	303	448
		8600	16 x 6K*	LT235/85R 16E	51	80	352	552
F-250 (4x2) SC	155 inch (3937 mm)	8800	16 x 6K*	LT235/85R 16E	51	80	352	552

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Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
F-250 (4x4) RC	133 inch (3378 mm)	6800	16 x 6K	LT 215/85R 16D	51	51	352	352
			16 x 6K	LT 235/85R 16D	44	44	303	303
			16 x 6K	LT 235/85R 16E	44	44	303	303
			16 x 6K	7.50R 16D	45	50	310	345
			16 x 6K*①	LT 215/85R 16D	65	65	448	448
			16 x 6K①	LT 235/85R 16D	58	58	400	400
			16 x 6K①	LT 235/85R 16E	58	58	400	400
			16 x 6K①	7.50R 16D	60	60	414	414
		8600	16 x 6K*	LT 235/85R 16E	44	80	303	552
			16 x 6K①	LT 235/85R 16E	58	80	400	552
F-250 (4x4) SC	155 inch (3937 mm)	8800	16 x 6K*	LT 235/85R 16E	51	80	352	552
F-350 (4x2) S/R, CHC	133 inch (3378 mm)	8800	16 x 6K*	LT 235/85R 16E	51	80	352	552
F-350 (4x2) Crew Cab	168 inch (4278 mm)	9200	16 x 6K*	LT 235/85R 16E	51	80	352	552
			16 x 6K①	LT 235/85R 16E	65	80	448	552
F-350 (4x4) CHC	133 inch (3378 mm)	8800	16 x 6K*	LT 235/85R 16E	51	80	352	552
			16 x 6K①	LT 235/85R 16E	65	80	448	552
F-350 (4x4) Crew Cab	168 inch (4278 mm)	9200	16 x 6K*	LT 235/85R 16E	58	80	352	552
F-350 D/R, RC	133 inch (3378 mm)	10000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	45	60	345	414
F-350 D/R, SC	155 inch (3937 mm)	10000	16 x 6K	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	45	60	345	414
F-350 D/R, SWB, CHC	137 inch (3475 mm)	10000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	7.50 16D	45	50	310	345
		11000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	50	60	345	414
F-350 D/R, LWB, CHC	161 inch (4085 mm)	10000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	7.50 16D	45	50	310	345
		11000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	50	60	345	414
F-350 D/R Crew Cab	168 inch (4278 mm)	10000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	50	60	345	414
F-350 D/R (4x4) CHC	137 inch (3475 mm)	11000	16 x 6K*⑤	LT 235/85R 16E	65	65	448	448
			16 x 6K⑤	7.50 16D	55	60	380	414
			16 x 16K①⑤	LT 235/85R 16E	65	65	448	448
F-350 D/R (4x4) CHC	161 inch (4085 mm)	11000	16 x 6K⑤	LT 235/85R 16E	65	65	448	448
F-Super Duty D/R, SWB, CHC	137 inch (3480 mm)	14500	16 x 6K⑥	LT 235/85R 16E	65	80	448	504
F-Super Duty D/R, LWB, CHC	161 inch (4085 mm)	14500	16 x 6K⑥	LT 235/85R 16E	65	80	448	504
F-Super Duty Commercial Stripped Chassis D/R	158 inch (4013 mm)	16000	16 x 6K⑥	LT 235/85R 16E	80	80	552	552
F-Super Duty Motor Home Chassis D/R	178 inch (4521 mm)	16000	16 x 6K⑥	LT 235/85R 16E	80	80	552	552
F-Super Duty Motor Home Chassis D/R	208 inch (5283 mm)	16000	16 x 6K⑥	LT 235/85R 16E	80	80	552	552

Notes

* Minimum wheel/tire sizes recommended for gross vehicle weight rating (front and rear). All other combinations are optional.

①Vehicles for Heavy Duty Front End option.
②Vehicles with Snow Plow Prep option.
⑤Requires 2500 lb. Wheel
⑥Requires 2750 lb. Wheel

For all tire installations on any vehicle:
- Do not mix tire brands.
- Do not mix radials, bias or bias-belted tires.

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Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
E-150 Cargo Van	124 inch	5500	15 x 6.0JK*	P215/75R 15SL	35	35	241	241
			15 x 6.0JK	P225/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
		6100	15 x 6.0JK	P215/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
	138 inch	5500	15 x 6.0JK*	P205/75R 15SL	35	35	241	241
			15 x 6.0JK⑦	P225/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
		6100	15 x 6.0JK*	P225/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
		6500	15 x 6.0JK	P235/75R 15XL	41	41	283	283
E-150 Super Van	138 inch	6200	15 x 6.0JK*	P235/75R 15XL	41	41	283	283
E-150 Club Wagon 5/8 Passenger	138 inch	6600	15 x 6.0JK*	P235/75R 15XL	41	41	283	283
E-250 Cargo Van	138 inch	7200	16 x 6K*	LT 215/85R 16D	51	58	352	400
			16 x 6K	LT 215/85R 16E	51	58	352	400
		7900	16 x 6K	LT 215/85R 16E	51	73	352	
E-250 Super Van	138 inch	8100	16 x 6K*	LT 215/85R 16E	51	80	352	552
E-250 Club Wagon 8/12 Passenger	138 inch	8550	16 x 6K*	LT 215/85R 16E	58	80	400	552
E-350 Cargo Van	138 inch	9400	16 x 6K*⑧	LT 235/85R 16E	51	80	352	552
		9500	16 x 6K	LT 235/85R 16E	51	80	352	552
E-350 Super Van	138 inch	9000	16 x 6K*③	LT 235/85R 16E	51	80	352	552
E-350 Super Wagon 12/15 Passenger	138 inch	9100	16 x 6K*	LT 235/85R 16E	58	80	400	552
E-350 S/C, S/R	138 inch	9400	16 x 6K*	LT 235/85R 16E	44	80	303	552
	158 inch	9400	16 x 6K*	LT 235/85R 16E	44	80	303	552

⑦P225 Required with 5.8L Engine
⑧4.9L Engine Only

CF3947-2E

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Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
E-350 RV, C/A, D/R	138 inch	10500	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
	158 inch	11000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
	176 inch	11000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
E-350 Comm C/A, D/R	138 inch	10300	16 x 6K	LT 215/85R 16D	51	58	352	400
			16 x 6K	LT 215/85R 16E	51	58	352	400
		10000	16 x 6K*④	LT 215/85R 16D	51	58	352	400
			16 x 6K④	LT 215/85R 16E	51	58	352	400
	158 inch	10700	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
E-350 S/C, D/R	158 inch	10000	16 x 6K*	LT 215/85R 16D	51	58	352	400
			16 x 6K	LT 215/85R 16E	51	58	352	400

NOTES

* Minimum wheel/tire sizes recommended for gross vehicle weight rating (front and rear). All other combinations are optional.

①50 states only. Vehicles over 6000 lb. GVW in Canada only

②For customer selected front spring option

③Available with ambulance prep package

④School bus package only.

For all tire installation on any vehicle:

- Do not mix tire brands
- Do not mix radials, bias or bias-belted tires.

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SECTION 11-02 Wheels and Tires

SUBJECT	PAGE
DESCRIPTION	
Front Wheel Assembly	11-02-1
Front Wheel Assembly—Four-Wheel Drive	11-02-1
New Vehicle Break-In	11-02-1
Rear Wheel Assembly	11-02-1
DIAGNOSIS AND TESTING	11-02-1
REMOVAL AND INSTALLATION	
Front Wheel Lug Nut Stud	11-02-5
Front Wheel Replacement—F-350, E-350, F-Super Duty and F-Super Duty Stripped Chassis Vehicles Equipped With Dual Rear Wheels	11-02-2
Lug Nut Torque Requirement	11-02-4
REMOVAL AND INSTALLATION (Cont'd)	
Rear Wheel Lug Nut Stud	11-02-5
Rear Wheel Replacement—F-350, E-350, F-Super Duty and F-Super Duty Stripped Chassis Vehicles Equipped with Dual Rear Wheels	11-02-3
Tire Replacement Precautions	11-02-5
Wheel Inspection And Maintenance	11-02-4
Wheel Replacement—F-150—F-350, E-150—E-350, and Bronco Equipped with Single Rear Wheels	11-02-1
SPECIFICATIONS	11-02-7
VEHICLE APPLICATION	11-02-1

VEHICLE APPLICATION

Applies to F-150, F-250, F-350, E-150, E-250, E-350, F-Super Duty, F-Super Duty Stripped Chassis Vehicles and Bronco.

DESCRIPTION

Front Wheel Assembly

Each front wheel and tire assembly is attached by wheel lug nuts to its respective front hub and rotor assembly. Two opposed tapered roller bearings are installed in each front hub and rotor assembly. A grease retainer is installed at the inner end of the hub to prevent lubricant from leaking. The entire assembly is retained on its spindle by the adjusting nut, nut lock and cotter pin. Refer to Section 11-10, Wheels, Hubs and Bearings—Front (Except Front Drive).

Front Wheel Assembly—Four-Wheel Drive

A description of the front axle used on vehicles equipped with 4-wheel drive is found in Section 15-34, Front Driving Axle—Dana. The locking hub assemblies are described in Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive.

Rear Wheel Assembly

Information on rear wheels (hubs and drums) may be found in Section 11-11, Wheel Hubs and Bearings—Rear (Semi Floating Axle) and 11-14, Wheel Hubs and Bearings—Rear (Full Floating Axle).

New Vehicle Break-In

WARNING: FOR VEHICLES EQUIPPED WITH SINGLE REAR WHEELS, RE-TIGHTEN THE WHEEL LUG NUTS AFTER 800 KM. (500 MILES) OF NEW VEHICLE OPERATION ACCORDING TO THE PROCEDURES FOUND IN THE REMOVAL AND INSTALLATION PORTION OF THIS SECTION. FOR VEHICLES EQUIPPED WITH DUAL REAR WHEELS, RE-TIGHTEN THE WHEEL LUG NUTS TO SPECIFICATIONS AFTER 160 KM. (100 MILES) AND AGAIN AFTER 800 KM. (500 MILES) OF NEW VEHICLE OPERATION, AND AT THE INTERVALS SPECIFIED IN SECTION 50-02, PRE-DELIVERY AND NON-EMISSION SCHEDULED MAINTENANCE ACCORDING TO THE PROCEDURES FOUND IN THE REMOVAL AND INSTALLATION PORTION OF THIS SECTION. THIS IS REQUIRED TO PERMIT THE WHEEL CLAMPING SYSTEM TO SEAT PROPERLY SO THAT THE WHEEL LUG NUTS WILL HOLD A UNIFORM CLAMP LOAD AND REMAIN FULLY TIGHTENED. RETIGHTENING TO SPECIFICATION IS ALSO REQUIRED AT 800 KM. (500 MILES) AFTER ANY WHEEL CHANGE OR ANY OTHER TIME THE LUG NUTS HAVE BEEN LOOSENED. IMPROPERLY TIGHTENED WHEEL LUG NUTS COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

DIAGNOSIS AND TESTING

For diagnostic and testing procedures, refer to Section 11-01, General Wheel and Tire Service.

REMOVAL AND INSTALLATION

Wheel Replacement—F-150—F-350, E-150—E-350, and Bronco Equipped with Single Rear Wheels

Refer to Fig. 1.

Removal

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH THE VEHICLE. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE INJURY. USE ONLY APPROVED WHEEL ASSEMBLIES.

1. Set parking brake and block diagonally opposite wheel. On vehicles equipped with an automatic transmission, place selector lever in the "P" position. On vehicles equipped with a manual transmission place the shift lever in reverse.
2. If equipped, remove the hub cap or wheel cover.
3. Loosen but do not remove the wheel lug nuts.

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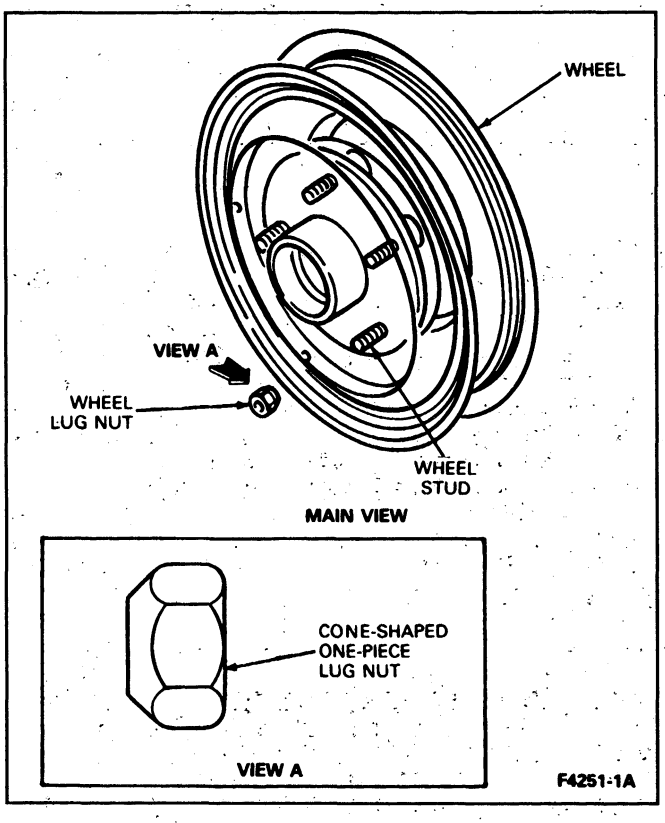


FIG. 1 Front and Rear Wheel Installation-F-150—F-350, E-150—E-350 and Bronco Equipped with Single Rear Wheels

4. Raise the vehicle until the wheel and tire clear the floor.
5. Remove the wheel lug nuts. Remove the wheel and tire assembly.

Installation

WARNING: WHENEVER A WHEEL IS INSTALLED, ALWAYS REMOVE ANY CORROSION, DIRT OR FOREIGN MATERIAL THAT MAY BE PRESENT ON THE MOUNTING SURFACES OF THE WHEEL OR THE SURFACE OF THE HUB, DRUM OR ROTOR THAT CONTACTS THE WHEEL. INSTALLING WHEELS WITHOUT PROPER METAL-TO-METAL CONTACT AT THE WHEEL MOUNTING SURFACES CAN CAUSE THE WHEEL LUG NUTS TO LOOSEN AND COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

1. Position the wheel on the hub and rotor or the hub and drum assembly.
2. Install the lug nuts making sure that the cone ends of the nuts face inward.
3. With the lug nuts loosely installed, turn the wheel until one nut is at the top of the bolt circle. Tighten the nut until snug. In a criss-cross type manner, tighten the remaining nuts until snug to minimize runout. Lower the vehicle.
4. Evenly tighten the nuts in the torque sequence shown in Fig. 2 to the torque listed in the Specifications portion of this section.

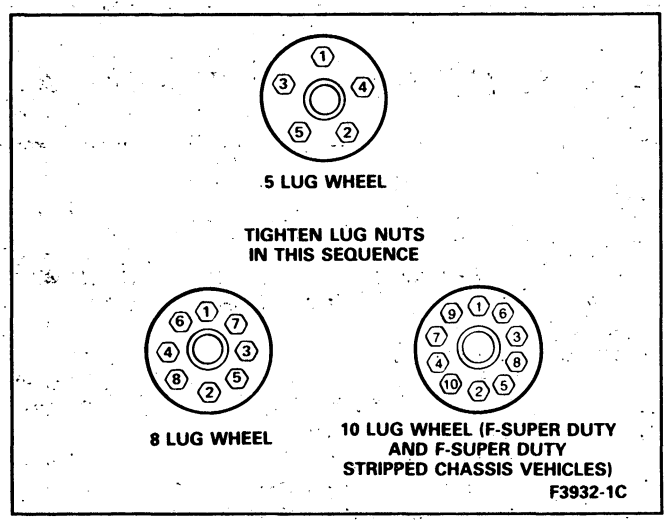


FIG. 2 Wheel Lug Nut Torque Sequence

Front Wheel Replacement—F-350, E-350, F-Super Duty and F-Super Duty Stripped Chassis Vehicles Equipped With Dual Rear Wheels

Refer to Fig. 3.

Removal

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH THE VEHICLE. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE INJURY. USE ONLY APPROVED WHEEL ASSEMBLIES.

WARNING: USE ONLY INTEGRAL TWO-PIECE SWIVELING LUG NUTS ON VEHICLES EQUIPPED WITH DUAL REAR WHEELS. DO NOT ATTEMPT TO USE CONE SHAPED ONE-PIECE LUG NUTS ON THESE VEHICLES. IF USED, CONE SHAPED ONE-PIECE LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS ON THIS VEHICLE. DO NOT ATTEMPT TO USE PRESENT DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE.

1. Set parking brake and block diagonally opposite wheel. On vehicles equipped with an automatic transmission, place selector lever in the "P" position. On vehicles equipped with a manual transmission, place the shift lever in reverse.
2. If equipped, remove the hub cap or wheel cover.
3. Loosen but do not remove the wheel lug nuts.
4. Raise the vehicle until the wheel and tire clear the floor.
5. Remove the wheel lug nuts. Remove the wheel and tire from the hub and rotor.

Installation

WARNING: WHENEVER A WHEEL IS INSTALLED, ALWAYS REMOVE ANY CORROSION, DIRT OR FOREIGN MATERIAL THAT MAY BE PRESENT ON THE MOUNTING SURFACES OF THE WHEEL OR THE SURFACES OF THE HUB AND ROTOR THAT

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CONTACTS THE WHEEL. INSTALLING WHEELS WITHOUT PROPER METAL-TO-METAL CONTACT AT THE WHEEL MOUNTING SURFACES CAN CAUSE THE WHEEL LUG NUTS TO LOOSEN AND COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

1. Mount the front wheel on the front hub and rotor with the wheel dish facing inboard. Align the wheel with the small indexing hole (located in the wheel between the stud holes) with the alignment pin in the hole in the gap. Make sure that the wheel is flush with the hub mounting surface so there is no gap between the hub and wheel.
2. Install and tighten until snug the 8 integral two-piece swiveling lug nuts (nut and washer assembly).
3. With the lug nuts loosely installed, turn the wheel until one nut is at the top of the bolt circle. Tighten the nut until snug. In a criss-cross type manner, tighten the remaining lug nuts until snug to minimize runout. Lower the vehicle to the floor.
4. Evenly tighten the nuts in the torque sequence shown in Fig. 2 to the torque listed in the Specifications portion of this section.

Rear Wheel Replacement—F-350, E-350, F-Super Duty and F-Super Duty Stripped Chassis Vehicles Equipped with Dual Rear Wheels

Refer to Fig. 4 and Fig. 5.

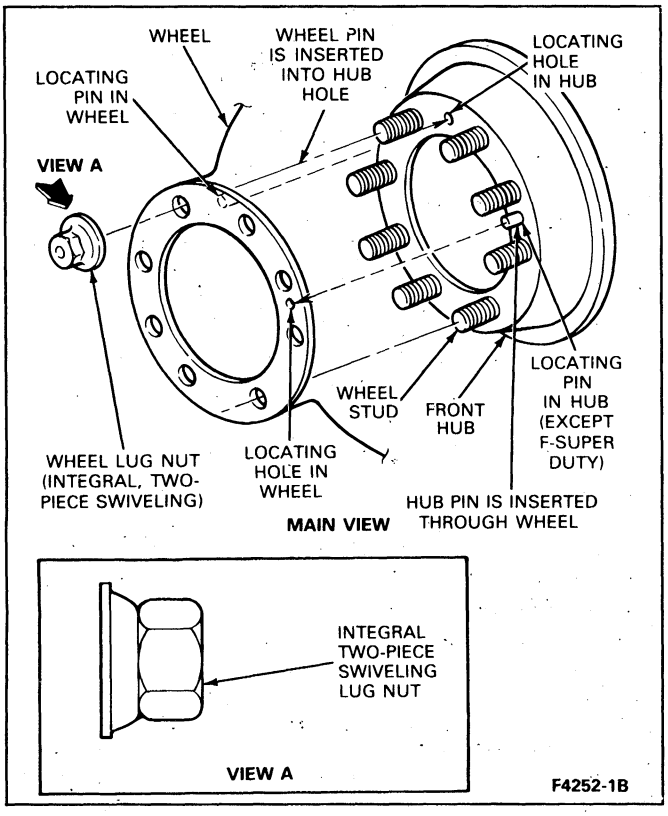


FIG. 3 Front Wheel Installation—F-350, E-350 Equipped with Dual Rear Wheels, F-Super Duty and F-Super Duty Stripped Chassis Similar Except 10 Stud Hub

Removal

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH THE VEHICLE. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE INJURY. USE ONLY APPROVED WHEEL ASSEMBLIES.

WARNING: USE ONLY INTEGRAL TWO-PIECE SWIVELING LUG NUTS ON VEHICLES EQUIPPED WITH DUAL REAR WHEELS. DO NOT ATTEMPT TO USE CONE SHAPED ONE-PIECE LUG NUTS ON THESE VEHICLES. IF USED, CONE SHAPED ONE-PIECE LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS ON THIS VEHICLE. DO NOT ATTEMPT TO USE PRESENT DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE.

NOTE: F-Super Duty and F-Super Duty Stripped Chassis vehicles require usage of center-pilot design wheel

1. Set parking brake and block diagonally opposite wheel. On vehicles equipped with an automatic transmission, place selector lever in the "P" position. On vehicles equipped with a manual transmission, place the shift lever in reverse.
2. If equipped, remove the hub cap or wheel cover.
3. Loosen but do not remove the wheel lug nuts.
4. Raise the vehicle until the wheel and tire clear the floor.
5. Remove the wheel lug nuts. Remove the wheel and tire from the hub and drum.

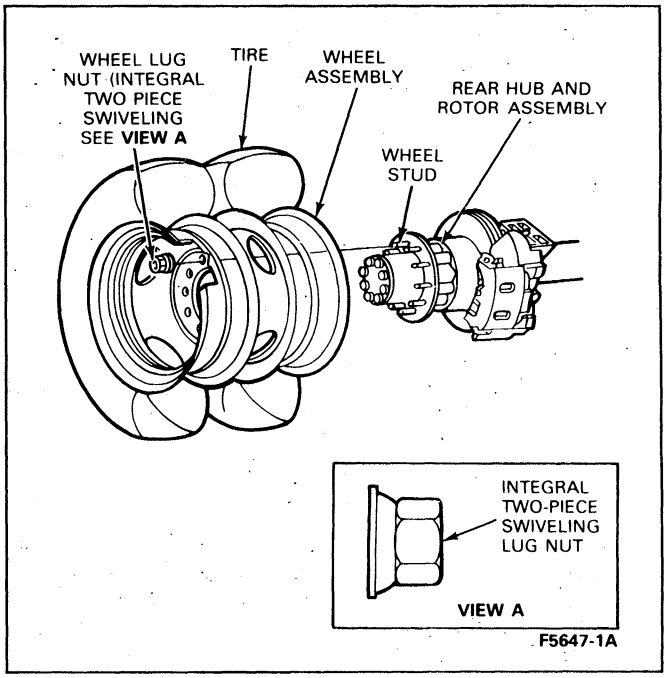


FIG. 4 Rear Wheel Installation—F-Super Duty and F-Super Duty Stripped Chassis Vehicles—Dual Rear Wheels

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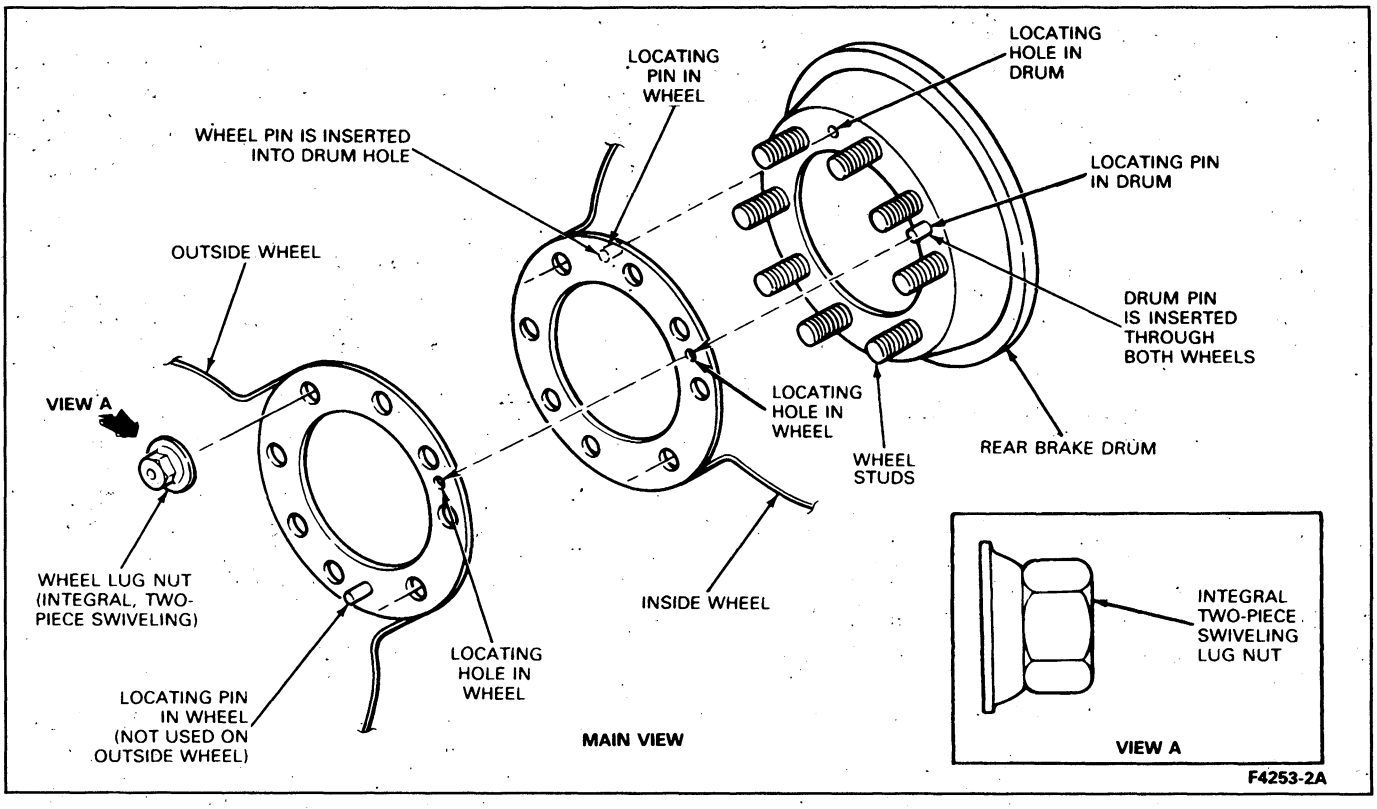


FIG. 5 Rear Wheel Installation—F-350—E-350 Equipped with Dual Rear Wheels

Installation

1. **WARNING: WHENEVER A WHEEL IS INSTALLED, ALWAYS REMOVE ANY CORROSION, DIRT OR FOREIGN MATERIAL THAT MAY BE PRESENT ON THE MOUNTING SURFACES OF THE WHEELS OR THE SURFACES OF THE HUB AND DRUM THAT CONTACTS THE WHEEL. INSTALLING WHEELS WITHOUT PROPER METAL-TO-METAL CONTACT AT THE WHEEL MOUNTING SURFACES CAN CAUSE THE WHEEL LUG NUTS TO LOOSEN AND COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.**
2. Mount the inner wheel on the rear hub with the wheel dish facing inboard. Align the wheel with the small indexing hole (located in the wheel between the stud holes) with the alignment pin in the hole in the hub. Make sure that the wheel is flush with the hub mounting surface so there is no gap between the hub and wheel.
3. Install the outer rear so it is flush against the inner wheel with the hub alignment pin protruding through the wheel index hole.
4. Install and tighten until snug the integral two-piece swiveling lug nuts (nut and washer assembly).
5. With the lug nuts loosely installed, turn the wheel until one nut is at the top of the bolt circle. Tighten the nut until snug. In a criss-cross type manner, tighten the remaining lug nuts until snug to minimize runout. Lower the vehicle to the floor.
6. Evenly tighten the nuts in the torque sequence shown in Fig. 2 to the torque listed in the Specifications portion of this Section.

Lug Nut Torque Requirement

WARNING: LUG NUTS MUST BE RETIGHTENED TO PROPER TORQUE SPECIFICATION AT 800 KM (500 MILES) OF NEW VEHICLE OPERATION AND VEHICLES WITH DUAL REAR WHEELS. RETIGHTEN TO PROPER TORQUE SPECIFICATION AT 160 KM (100 MILES) AND ALSO AT 800 KM (500 MILES) OF NEW OPERATION AND AT THE INTERVALS SPECIFIED IN SECTION 10-02, MAINTENANCE.

RETIGHTEN TO PROPER TORQUE SPECIFICATIONS AT 800 KM. (500 MILES) AFTER ANY WHEEL CHANGE OR ANY OTHER TIME THE LUG NUTS HAVE BEEN LOOSENED.

IMPROPERLY TIGHTENED WHEEL LUG NUTS COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

Wheel Inspection And Maintenance

Check the wheel nut torque and retighten the lug nuts to the specified torque according to procedures listed in the Removal and Installation portion of this section. Refer to Section 10-02 Maintenance for the torque maintenance schedules.

CAUTION: Replace wheels if they are bent, cracked, leaking air or heavily rusted or if the lug nuts often become loose. Do not use bent wheels that have been straightened and do not use inner tubes in leaking wheels. Do not replace wheels with used wheels. Wheels that have been straightened or are leaking air or are used, may have structual damage and could fail without warning. Check for damage that could affect the runout of the wheels. Wobble or shimmy will eventually damage the wheel bearings.

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Tire Replacement Precautions

The tire must be completely deflated before removal, and the bead must not be damaged by a tire iron. (Safety procedures for truck tire servicing is found in Section 11-01, General Wheel and Tire Service under Safety.)

After installation, a tube tire should be inflated to recommended pressure, deflated, and then inflated again to insure that the tube is not folded inside the tire. Be sure the tube flap is properly positioned before inflating the tire. **It is important that each front and rear tire and wheel be balanced.**

When installing tires thoroughly lubricate the tire beads with Rubber Lubricant, D9AZ-19583-A (ESA-M1B6A) or equivalent. Inflate the tire until both beads seat against the rim of the wheel, then deflate to the specified "Tire Inflation Pressures" shown on the safety certification label attached to the L.H. door pillar. To seat the tire beads, the initial inflation for truck-type tubeless tires, 344 kPa (50 psi) maximum; for truck-type tube tires 517 kPa (75 psi) maximum. Follow the instructions supplied with the Rotunda (model 084-00001 or an equivalent) tire changer. Refer to Section 11-01, General Wheel and Tire Service for diagnosis and testing procedures, safety procedures and illustrations.

Four Wheel Disc Brake Hub and Rotor—F-Super Duty and F-Super Duty Stripped Chassis Vehicles

Description

The hub and rotor assembly of these vehicles is designed as a two piece assembly allowing it to be replaced as individual components, or as an assembly. The front and rear brake rotors are the same and are attached to either the front or rear hub assembly with 10 screw and washer assemblies tightened to 100-120 N·m (73-80 ft-lb).

Remove the front or rear hub and rotor assembly as outlined in Section 12-24, Disc Brakes Light and Heavy Duty-Sliding Caliper.

For vehicles with two-piece hub and rotor assemblies, remove and install the wheel studs as outlined in this Section under Rear Wheel Lug Nut Stud removal and installation.

Front Wheel Lug Nut Stud

Refer to Fig. 6.

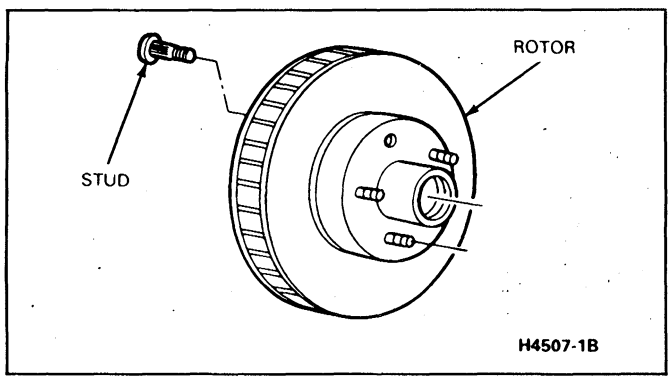


FIG. 6 Front Wheel Lug Nut Stud

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly as described in this Section.
3. Remove the rotor as described in Section 12-24, Disc Brakes—Light and Heavy Duty, Sliding Caliper.
4. Position the rotor in a press so ram pressure is not directly exerted on the rotor surface (Fig. 7). With appropriate press stock, press the lug nut stud from the rotor. Discard the stud.

Installation

1. Position a new stud in the hole. Align the serrations of the new stud with the serration marks from the old stud. With a hammer lightly tap the stud until the serrations on the stud are started in the hole. Make sure the stud is not installed in an "off-center" position in the rotor hub.
2. Position the rotor in a press so the rotor is supported on the wheel mounting flange. Be sure to allow enough clearance for the stud to pass through the hole. Do not apply ram pressure directly on the rotor surface. With appropriate press stock, press the stud in position until the stud is flush against the inner surface of the rotor hub (Fig. 8).
3. Install the rotor as described in Section 12-24, Disc Brakes Light and Heavy Duty—Sliding Caliper.
4. Install the wheel and tire as described in this Section.

Rear Wheel Lug Nut Stud

Refer to Fig. 9

Removal

CAUTION: Never use a hammer to remove the stud. Damage to the hub or bearing may result.

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly as described in this Section.
3. Remove the brake drum from the axle shaft or hub studs.
4. Using Tool T74P-3044-A1, press the stud from its seat in the hub (Fig. 10). The stud may also be removed by pressing it out using an appropriate sized socket and C-clamp. Discard the stud.

Installation

1. Insert new stud in hole in the shaft or hub. Rotate stud slowly to assure the serrations are aligned with those made by the original stud.
2. Place four flat washers over the outside end of the stud and thread the wheel nut with the flat side against the washers. Tighten the wheel nut until the stud head seats against the back side of the shaft or hub.

   CAUTION: Do not use air tools as the serrations may be stripped from the stud.
3. Remove wheel nut and washers.
4. Install brake drum and wheel as described in this Section.
5. Lower the vehicle.

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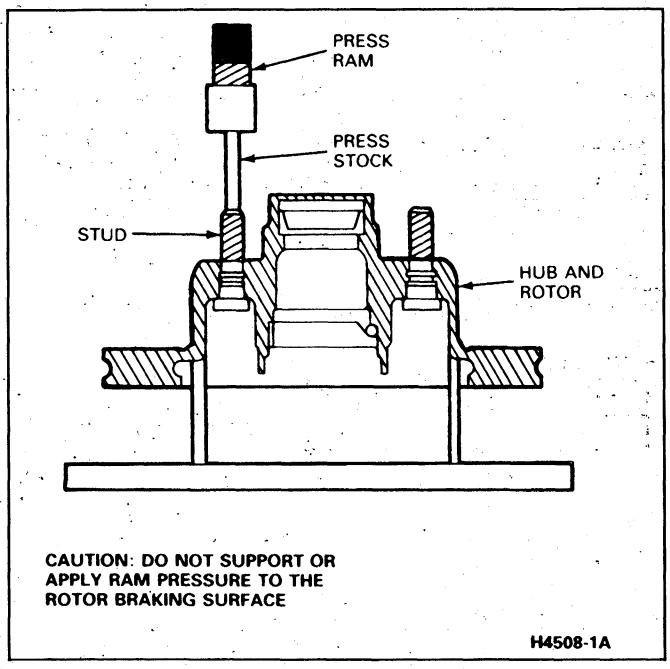


FIG. 7 Front Wheel Lug Nut Stud Removal

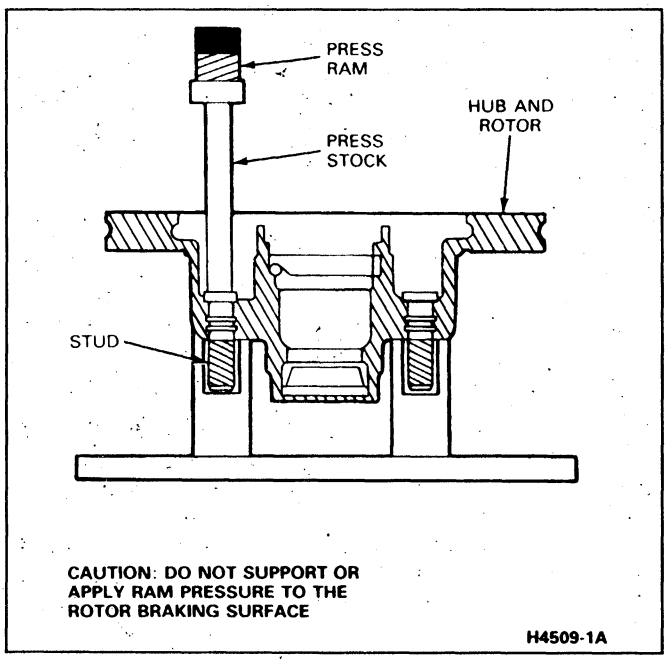


FIG. 8 Front Wheel Lug Nut Stud Installation

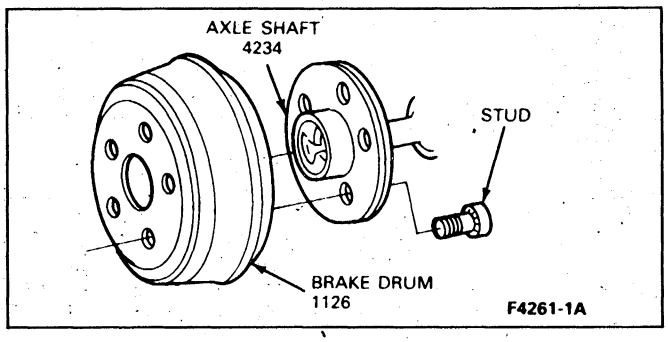


FIG. 9 Rear Wheel Lug Nut Stud

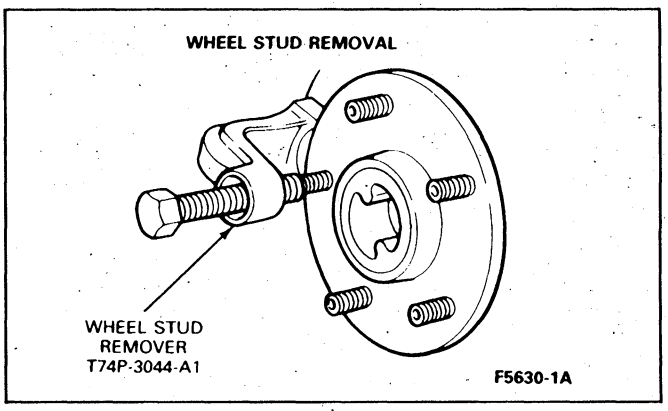


FIG. 10 Rear Wheel Lug Nut Stud Removal

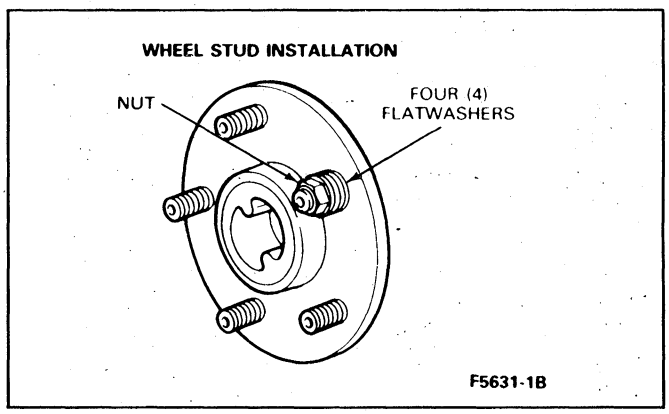


FIG. 11 Rear Wheel Lug Nut Stud Installation

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SPECIFICATIONS

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty and F-Super Duty Stripped Chassis Vehicles	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2E

SPECIAL SERVICE TOOLS

Number	Description
T74P-3044-A1	Wheel Stud Remover

CF5642-1A

ROTUNDA EQUIPMENT

Number	Description
084-00001	Tire Changer

CF3416-1D

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SECTION 11-10 Wheels, Hubs and Bearings—Front (Except Front Drive)

SUBJECT	PAGE
ADJUSTMENTS	
Front Wheel Bearing Adjustment	11-10-2
F150—F-350, F-Super Duty (Chassis Cab) and E-150—E-350	11-10-2
DESCRIPTION	
Front Wheel Assembly	11-10-1
REMOVAL AND INSTALLATION	
Front Wheel Grease Seal and Bearing	11-10-2
SPECIFICATIONS	11-10-4
VEHICLE APPLICATION	11-10-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 (4x2), F-Super Duty and F-Super Duty Stripped Chassis Vehicles.

DESCRIPTION

Front Wheel Assembly

Each front wheel and tire assembly is bolted to its respective front hub and rotor assembly. Two opposed tapered roller bearings are installed in each hub, (Fig. 1). A grease retainer is installed at the inner end of the hub to prevent lubricant from leaking onto the rotor. The entire assembly is retained to its spindle by the adjusting nut, washer, retainer, cotter pin and grease cap.

E-350, F-350, F-Super Duty and F-Super Duty Stripped Chassis vehicles equipped with dual wheel rear axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

ADJUSTMENTS

Wheel Bearing Adjustment—F-Super Duty Stripped Chassis Vehicles

Refer to Figure 2.

To check the wheel bearing adjustment, raise the front of the vehicle. Then, grasp the tire at the sides, and alternately push inward and pull outward on the tire. If any looseness is felt, adjust the front wheel bearings.

1. Raise the vehicle until the tire clears the floor and install safety stands.
2. Remove the wheel cover. Remove the grease cap from the hub.

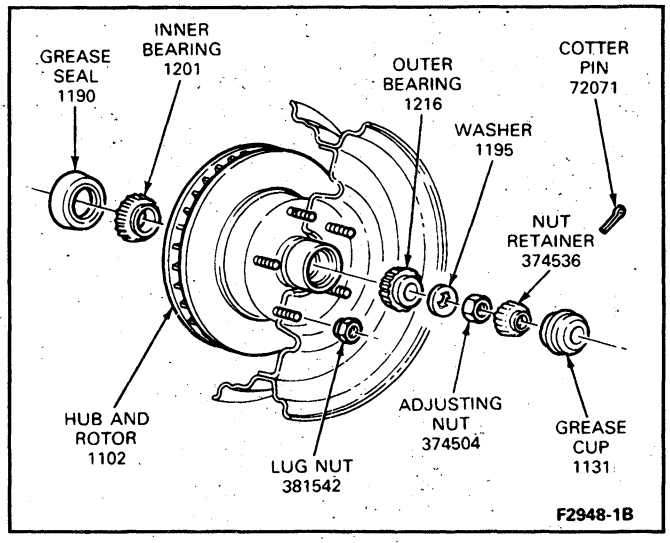


FIG. 1 Front Hub and Rotor Assembly, Bearings and Grease Seal—Typical Vehicles with Single Rear Wheels

3. Wipe the excess grease from the end of the spindle. Remove the cotter pin and locknut.
4. Loosen the adjusting nut three turns. Attempt to obtain running clearance between the rotor brake surface and the shoe/linings by rocking the wheel, hub and rotor assembly in and out several times to push the shoe and linings away from the rotor, or by light tapping on the caliper housing or some other means that does not damage the rotor lining surfaces. DO NOT PRY ON THE CALIPER PHENOLIC PISTON. If running clearance cannot be maintained throughout bearing adjustment in Steps 5 and 6, the caliper must be removed. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
5. Tighten the wheel bearing adjusting nut to 23-34 N·m (17-25 ft-lb) while rotating the disc brake rotor in the opposite direction.
6. Back the nut off approximately 120° to 180°.
7. Tighten the nut to 2.03-2.26 N·m (18-20 in-lb) while rotating the disc brake rotor.

- End play should be .006-.127mm (.00025-.005 inch).

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- Torque required to rotate the hub should be 1.13-2.82 N·m (10-25 in-lb).

8. Install the retainer, new cotter pin, and grease cap.
9. Install the caliper (if removed).
10. Install the wheel and tire assembly.
11. Lower the vehicle and tighten the lug nuts to 190 N·m (140 ft-lb).
12. Install the wheel cover or hub cap, if so equipped.
13. Before driving the vehicle, pump the brake pedal several times to restore normal braking action.
14. After 800 kilometers (500 miles) of operation, retighten the lug nuts to specifications. Failure to retighten the lug nuts could result in the wheel coming off while the vehicle is in motion.

Front Wheel Bearing Adjustment

F150—F-350, F-Super Duty (Chassis Cab) and E-150—E-350

Refer to Figures 1 and 2.

To check the wheel bearing adjustment, raise the front of the vehicle. Then, grasp the tire at the sides, and alternately push inward and pull outward on the tire. If any looseness is felt, adjust the front wheel bearings.

1. Raise the vehicle until the tire clears the floor and install safety stands.
2. Remove the wheel cover. Remove the grease cap from the hub.
3. Wipe the excess grease from the end of the spindle. Remove the cotter pin and locknut.
4. Loosen the adjusting nut three turns. Attempt to obtain running clearance between the rotor brake surface and the shoe/linings by rocking the wheel, hub and rotor assembly in and out several times to push the shoe and linings away from the rotor, or by light tapping on the caliper housing or some other means that does not damage the rotor lining surfaces. DO NOT PRY ON THE CALIPER PHENOLIC PISTON. If running clearance cannot be maintained throughout bearing adjustment in Steps 5 and 6, the caliper must be removed. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
5. Tighten the wheel adjusting nut to 30-33 N·m (22-25 ft-lbs.) while rotating the disc brake rotor in the opposite direction.
6. Back off the adjusting nut 1/8 turn and install the retainer and new cotter pin without additional movement of the adjusting nut. Bearing end play should be 0.025-0.254mm (0.001-0.010 inch). Bend the ends of the cotter pin around the castellated flange of the locknut.
7. Check front wheel rotation. If the wheel rotates properly, reinstall the grease cap and wheel cover. If rotation is noisy or rough, remove and inspect the bearings. Service as required.
8. Before driving the vehicle, pump the brake pedal several times to restore normal brake pedal travel.

REMOVAL AND INSTALLATION

Front Wheel Grease Seal and Bearing

Removal

Refer to Figures 1 and 2.

Wheel bearing lubricant is a lithium-base grease, Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

Sodium-base grease is not compatible with lithium-base grease and should not be intermixed. Therefore, do not lubricate front and/or rear wheel bearings without first identifying the type of original wheel bearing lubricant. Usage of incompatible bearing lubricants could result in premature lubricant breakdown.

If bearing adjustment will not eliminate looseness or rough and noisy operation, the hub and bearings should be cleaned, inspected, and repacked with specified wheel grease. If the bearing cups or the cone and roller assemblies are worn or damaged, they should be replaced.

1. Raise the vehicle until the tire clears the floor and remove the wheel and tire assembly from the hub and rotor as described in Section 11-02, Wheels and Tires.
2. Remove the brake caliper, (refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper), and wire it to the underbody to prevent

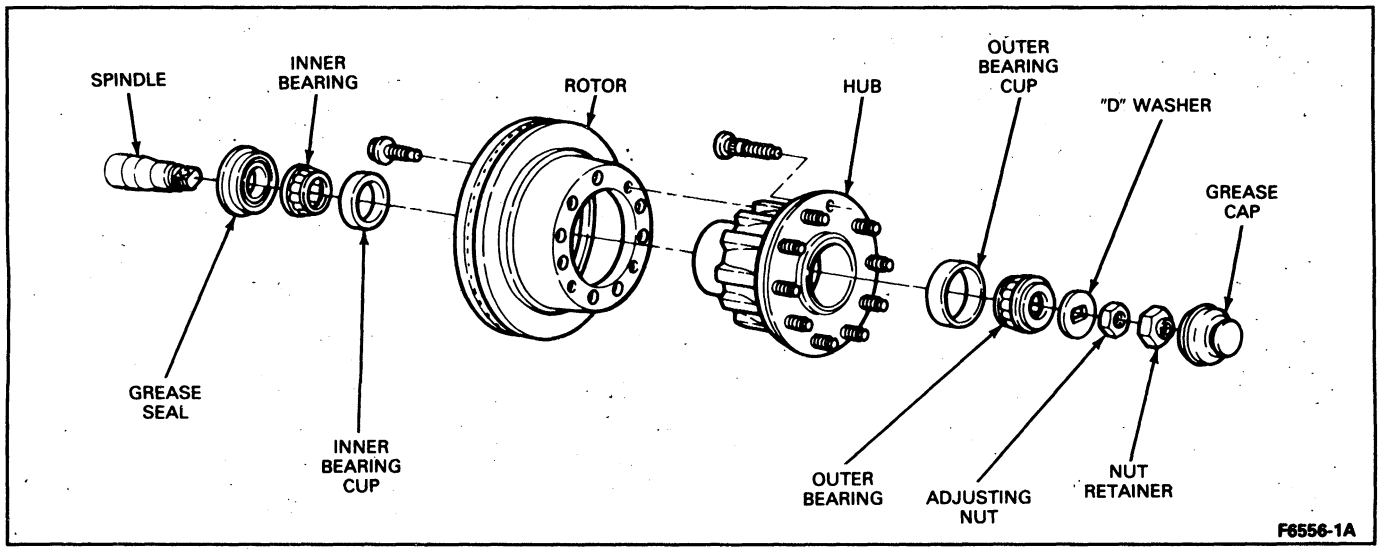


FIG. 2 Front Hub and Rotor Assembly, Bearings and Grease Seal—Typical Vehicles with Dual Rear Wheels

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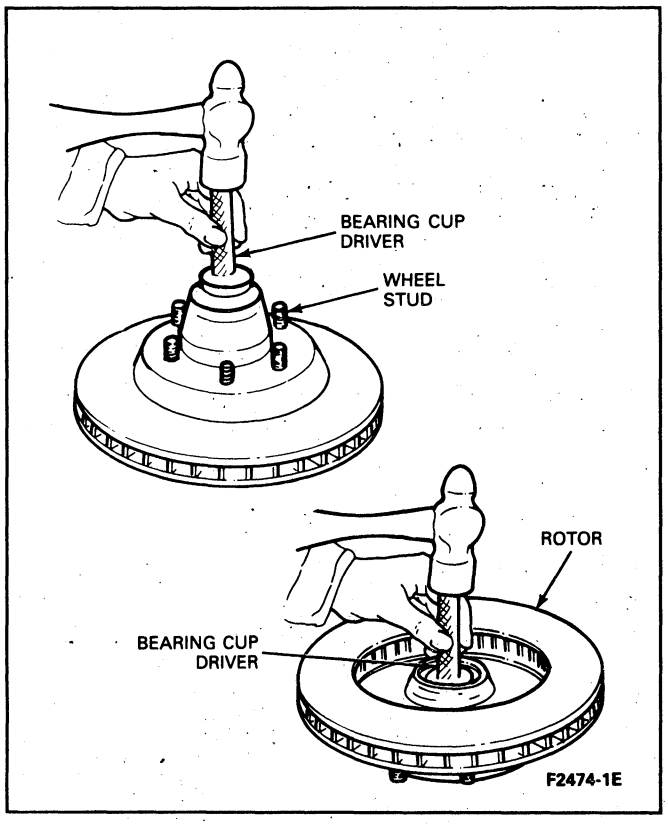


FIG. 3 Installing Bearing Cups—Typical

damage to the brake hose. It is not necessary to disconnect the hose from the caliper. Do not let the caliper hang with its weight on the brake hose or the hose may become stretched, twisted or ruptured.

3. Remove the grease cap, cotter pin, retainer adjusting nut and washer.
4. Remove the outer bearing cone and roller.
5. Pull the hub and rotor off the spindle and remove and discard the grease seal, if necessary.
6. Remove the inner bearing cone and roller from the hub. Remove all traces of old lubricant from bearings, hub and axle spindle.
7. Inspect the cups for scratches, pits or cracks. If the cups are worn or damaged, remove them with a drift. Clean the inner and outer bearing cones and rollers with solvent and dry thoroughly. **Do not spin the bearings dry with compressed air.**
8. Inspect the cones and rollers for cracks, nicks, brinelling, or seized rollers. Inspect the grease retainer and replace it if it is cracked, nicked, dented, or worn.
9. Cover the spindle with a clean cloth and brush all loose dust and dirt from the brake assembly using Rotunda Brake and Clutch Service Vacuum 091-00001 or equivalent. **Remove the cloth from the spindle carefully to prevent dirt from falling on the spindle.**

Installation

1. If inner or outer bearing cups were removed, install replacement inner and outer bearing cups in the hub with the appropriate bearing cup replacer tool (refer to the Special Service Tool chart in the

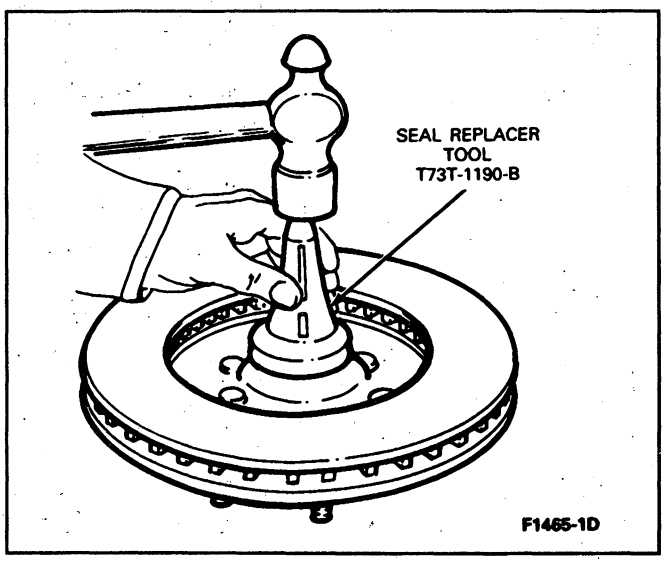


FIG. 4 Installing Grease Seal—Typical

Specifications portion of this section) and Driver Handle T80T-4000-W (Fig. 3). Be sure to seat the cups properly in the hub. The cups will be properly seated when they are fully bottomed. Replace grease retainers. Polish grease retainer journal on spindle with 400 grit sandpaper. Clean with clean cloth.

2. Pack the inside of the hub with lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Fill the hub until the grease is flush with the inside diameters of both bearing cups. Pack the bearing cones and rollers with wheel bearing grease. Use a bearing packer for this operation, Rotunda models 108-00074, 108-00076, or 108-00078, or equivalent. If a packer is not available, work as much lubricant as possible between the rollers and cages. Lubricate the cone surfaces with grease.
3. Place the inner bearing cone and roller in the inner cup and install the new grease seal with Seal Replacer, T73T-1190-B, (Fig. 4). Be sure that the seal is fully bottomed.
4. Install the hub and rotor on the wheel spindle. **Keep the hub centered on the spindle to prevent damage to the grease retainer or the spindle threads.**
5. Install the outer bearing cone and roller and the flat washer on the spindle, then install the adjusting nut, and adjust the wheel bearing as outlined under Adjustments in this Section.
6. Install the retainer, new cotter pin, and grease cap.
7. Install the caliper, (refer to Section 12-24, Disc Brakes-Light and Heavy Duty—Sliding Caliper).
8. Install the wheel and tire assembly on the hub as described in Section 11-02, Wheels and Tires.
9. Lower the vehicle and tighten the lug nuts to specification. Re-install the wheel cover or hub cap.
10. Before driving the vehicle, pump the brake pedal several times to restore normal brake pedal travel.
11. After 800 kilometers (500 miles) of operation, retighten the lug nuts to specifications. Failure to retighten the lug nuts could result in the wheel coming off while the vehicle is in motion.

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SPECIFICATIONS

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N·m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty and F-Super Duty Stripped Chassis Vehicles	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2E

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lb.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lb.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lb.	Universal
T58L-101-B	Puller Attachment	Universal — Use with Slide Hammer
T77F-1102-A	Bearing Cup Puller	Universal — Use with Slide Hammer
T75T-1170-A	Lock Wedge Replacer	E-250, E-350
TOOL-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T75T-1176-A	Threaded Drawbar	E-150 thru E-350 — Bearing Cup Installation
T73T-1190-B	Seal Replacer	Seal No. C7TZ-1190-D
T73T-1202-A	Bearing Cup Replacer	F-250, F-350, F-Super Duty, E-250 — Use with Driver Handle and Part No. 8A-1202-A
T73T-1217-B	Bearing Cup Replacer	F-250, E-250 Use with Driver Handle
D78P-1225-B	Bearing Cup Puller	Universal
D79T-4000-A	Outside Thread Chaser	Universal
T80T-4000-W	Driver Handle	Bearing Cup Installation
T73T-4222-A	Bearing Cup Replacer	F-250 — Use with Part No. CIVW-4222-A
T73T-4222-B	Bearing Cup Replacer	F-250, F-350, F-Super Duty — Use with Part No. B7A-4222-A
Rotunda Equipment		
Rotunda — 108-00074	Wheel Bearing Packer	Up to 4" Bearings
Rotunda — 108-00076	Wheel Bearing Packer	Up to 6" Bearings
Rotunda — 108-00078	Wheel Bearing Packer	Up to 6-1/2" Bearings
Rotunda — 091-00001	Brake and Clutch Service Vacuum	Universal

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SECTION 11-11 Wheel Hubs and Bearings—Rear (Semi-Floating Axle)

SUBJECT	PAGE
DESCRIPTION	
Rear Wheel Assembly	11-11-1
REMOVAL AND INSTALLATION	11-11-1
VEHICLE APPLICATION	11-11-1

VEHICLE APPLICATION

Bronco, E-150 Through E-250, F-150 Through F-250 (4x2), F-150 Through F-250 (4x4) Truck Models under 8500 lb GVW.

DESCRIPTION

Rear Wheel Assembly

E-150, F-150 and Bronco (Ford 8.8 Inch Ring Gear Rear Axle)

The rear wheel brake drum assembly is retained on the studs of the rear axle shaft flange by two retainers. The wheel (and tire) is mounted on the same rear axle shaft flange studs, and is held against the drum and axle shaft flange assembly by the wheel nuts. On the Ford 8.8 inch Ring Gear Axle, the rear wheel bearing and seal are pressed into the outer axle tube housing. The axle shaft is held in place by a C-clip in the differential case. When the C-clip is removed, the axle shaft can be taken out of the axle tube housing.

Rear Wheel Assembly

E-250 UNDER 8500 LBS GVW (DANA 9.75 Inch Ring Gear Axle)

F-250 UNDER 8500 LBS GVW (FORD 10.25 Inch Ring Gear Axle)

Eight studs, pressed into the axle shaft flange, serve as a mounting surface for the brake drum. The wheel and tire assembly mounts on the drum and axle flange assembly and is held in place by eight wheel lug nuts. The rear wheel bearing and seal are pressed into the outer axle tube housing. The axle shaft is held in place by a C-clip in the differential case. When the C-clip is removed, the axle shaft can be taken out of the axle tube housing.

REMOVAL AND INSTALLATION

Refer to Section 15-08, Integral Carrier Axle—Ford 8.8 Inch Ring Gear; Section 15-09 Integral Carrier Axle—10.25 inch Ring Gear and Section 15-05, Integral Carrier Axle-Dana for Removal and Installation Procedures.

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SECTION 11-12 Wheel Hubs and Bearings—Front Wheel Drive

SUBJECT	PAGE
ADJUSTMENTS	
Front Wheel Bearing Adjustment	11-12-2
Front Wheel Bearing Adjustment with Manual Locking Hubs	11-12-2
Bronco and F-150—F-250 (4x4) With Dana 44IFS or 44IFS/HD Front Driving Axle	11-12-2
DESCRIPTION AND OPERATION	
Automatic Locking Hubs Operation	11-12-1
Manual Locking Hubs Operation	11-12-2
DISASSEMBLY AND ASSEMBLY	
Front Wheel Grease Seal and Bearing Replacement and Repacking	11-12-5
REMOVAL AND INSTALLATION	
Automatic Locking Hubs	11-12-3
Bronco, F-150 (4x4)	11-12-3
Manual Locking Hubs	11-12-3
SPECIFICATIONS	11-12-7
VEHICLE APPLICATION	11-12-1

VEHICLE APPLICATION

Bronco, F-150 Through F-350 (4x4) Only.

DESCRIPTION AND OPERATION

The hub locks on Bronco and F-150—F-350 (4x4) vehicles equipped with four-wheel drive, either automatically or manually actuate the front driving axle. When actuated, the hub lock body assembly locks the hub and wheel and tire assembly to the front driving axle axleshaft. When released, the front driving axle axleshaft is disengaged from the hub body assembly and the hub and tire and wheel assembly rotate freely on the spindle.

Two tapered opposed roller bearings allow the hub and wheel and tire assembly to rotate on the spindle. A hub seal is installed inboard of the inner bearing to prevent wheel bearing lubricant from contaminating the brake caliper and rotor surfaces.

F-350 (4x4) equipped with dual wheel rear axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

Automatic Locking Hubs Operation

Electric Shift Transfer Case

2-WHEEL DRIVE—Shift the transfer case in the 2H position by pushing the LOW RANGE and/or 4 x 4 pushbuttons until both indicator lamps are off.

To disengage the automatic hub locks, shift the transmission to move the vehicle in the opposite direction (forward or reverse) and drive a minimum of 3 meters (10 feet) in a straight line. Always disengage the automatic hub locks before driving on dry, hard-surfaced roads.

NOTE: During axle break-in or operation in extremely cold temperatures (-10°F [-12°C] or below) and if the axle lubrication has had time to cool, the automatic hub locks may not disengage completely. It may be necessary to keep the hub locks engaged for 10 to 15 minutes while driving before they will disengage.

SHIFTING BETWEEN 2H AND 4H—The transfer case can be shifted between 2H and 4H with the vehicle stopped or at normal road speed by pushing the 4 x 4 button. The amber indicator lamp will illuminate when the transfer case is in 4-wheel drive.

HI/LOW RANGE SHIFTING—To shift to or from low range, stop the vehicle and shift automatic transmission to N (NEUTRAL) or disengage clutch on manual transmission before pushing the LOW RANGE button. The LOW RANGE indicator lamp will illuminate in low range.

Attempting to shift to or from low range with the vehicle in motion will cause the LOW RANGE lamp to flash. The LOW RANGE lamp will continue to flash until the prior shift position is reselected or the previous procedure is followed.

The 4 x 4 and Low Range button will illuminate with the headlamps or parking lamps on. It may be dimmed or brightened by rotating the instrument panel thumb wheel.

NOTE: Do not shift transfer case from 2H to 4H with the rear wheels spinning while accelerating vehicle from a standstill, or with vehicle in motion with temperature at -15°C (5°F) or below, otherwise damage can occur to the drivetrain.

NOTE: Initial shifts from 2H to 4H, with vehicle in motion, may cause a driveline clunk noise which is the result of the front axle automatic locking hubs engaging. This engagement noise is normal and will not occur with subsequent shifts between 2H and 4H.

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Manual Locking Hubs Operation

(Refer to Fig. 1).

Two-Wheel Drive

Shift the transfer case to the two-wheel drive position (2H) and turn the hub lock selector knob counter clockwise to the "FREE" position.

Four-Wheel Drive

Lock both hubs by turning the selector knob clockwise to the "LOCK" position. If the hub teeth do not engage with the knob in this position, a slight movement of the wheel in either direction will complete the lock.

If the vehicle is stopped, place the transmission in neutral and select transfer case shift position.

If the vehicle is moving, the transfer case may be shifted between 2H and 4H only, providing that the hub locks are in the "LOCK" position.

Shifting to or from the 4L position requires that the vehicle be fully stopped and the transmission in neutral.

CAUTION—Both hubs must be set in the same function to avoid excess front differential wear on Non-Traction-Lok front axles or steering pull on Traction-Lok front axles.

CAUTION—Clashing of gears and resulting transfer case damage will occur if you attempt to shift to or from 4L while the vehicle is in motion or if you attempt to shift from 2H to 4H with the hub locks in the "FREE" position while the vehicle is in motion.

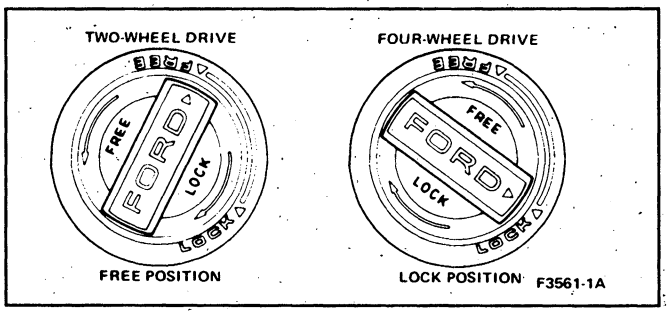


FIG. 1 Four Wheel Drive Wheel Hubs—Manual Locking Hubs

If it is necessary to shift to or from 4L, bring the vehicle to a full stop before doing so.

ADJUSTMENTS

Front Wheel Bearing Adjustment with Manual Locking Hubs

Bronco and F-150—F-250 (4x4) With Dana 44IFS or 44IFS/HD Front Driving Axle

1. Raise the vehicle and install safety stands.
2. Remove the hub lock assembly. Refer to Automatic Locking Hub or Manual Locking Hub removal and installation procedures in this Section.
3. Using a torque wrench and Spanner Locknut Wrench, T86T-1197-A, apply inward pressure to unlock the adjusting nut locking splines, and turn the nut clockwise to tighten to 68-81 N·m (50-60 ft-lbs) while rotating the wheel back and forth to seat the bearing (Fig. 2).

   NOTE: After 95 N·m (70 ft-lbs.) of torque, the adjusting nut will no longer tighten. The threaded nut portion will ratchet in the assembly upon approaching the specified torque. Continue tightening until the specified torque is obtained.
4. Apply inward pressure on the Spanner Locknut Wrench to disengage the adjusting nut locking splines and back off the adjusting nut approximately 180 degrees (Fig. 2).
5. Retighten the adjusting nut to 20 N·m (15 ft-lbs.). Remove the tool and torque wrench.
6. Check that the final end play of the wheel on the spindle is 0.00-0.15mm (0.00-0.006 inch).
7. Install the hub lock assembly as described in this Section.
8. Remove the safety stands. Lower the vehicle.

Front Wheel Bearing Adjustment

F-150 with Automatic Locking Hubs—F-250 H.D.—F-350 (4x4) with Dana 44, 50IFS and Dana 60 Monobeam Front Driving Axle

Refer to Fig. 3.

1. Raise the vehicle and install safety stands.

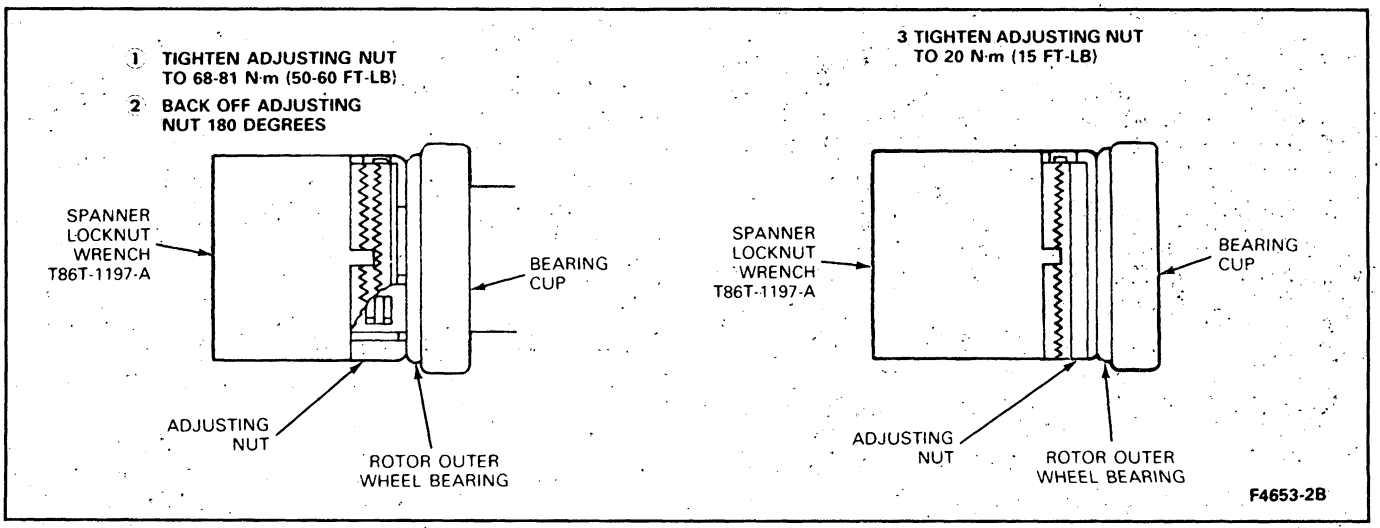


FIG. 2 Front Wheel Bearing Adjustment—Bronco and F-150—F-250 (4x4) with Dana 44 Front Driving Axle

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2. Remove the hub lock assembly. Refer to Manual Locking Hub in the Removal and Installation portion of this Section.
3. Remove the outer locknut with Spanner Locknut Wrench, D85T-1197-A. Remove the lockwasher.
4. Using Spanner Locknut Wrench, D85T-1197-A, tighten the inner locknut to 68 N·m (50 ft-lbs.) to seat the bearing.
5. Back off the inner locknut and retighten to 41-54 N·m (31-39 ft-lbs.).
6. While rotating the hub, back off the locknut 135-150 degrees.
7. Install the lockwasher so the key is positioned in the spindle groove. Rotate the inner locknut so the pin is aligned into the nearest lockwasher hole.
8. Install the outer locknut and tighten to 217-278 N·m (160-205 ft-lbs.) using Spanner Locknut Wrench, D85T-1197-A.
9. Check the final end play of the spindle, it should be 0.00-0.15mm (0.000-0.006 inch).
10. Install the hub locks as described in this Section.
11. Remove the safety stands. Lower the vehicle.

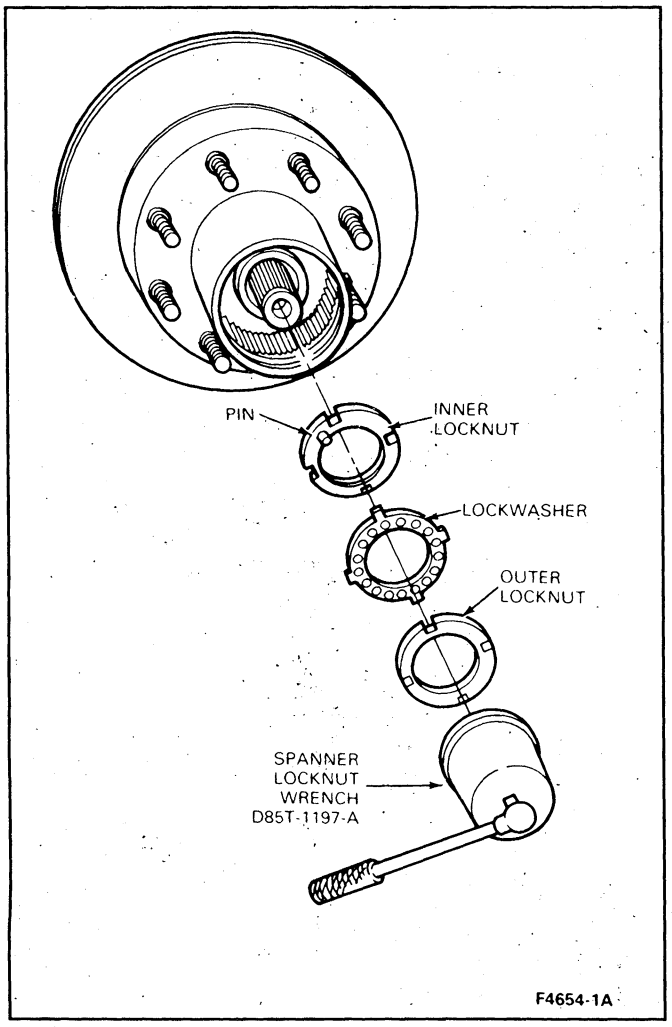


FIG. 3 Outer Locknut, Lockwasher and Inner Locknut—F-250—F-350 (4x4) with Dana 50 IFS and Dana Model 60 Monobeam Front Driving Axle

REMOVAL AND INSTALLATION

Manual Locking Hubs

Bronco, and F-150-F350 (4x4)

Refer to Fig. 4.

Removal

1. Separate the cap assembly from the body assembly by removing the six Allen-head capscrews and remove the cap from the body (Fig. 5).
2. Remove the snap ring that retains the axle shaft in the hub body assembly (Fig. 6).
3. Remove the lockring seated in the groove of the wheel hub (Fig. 7).
4. Remove the body assembly from the hub. If the body is difficult to remove, install two capscrews and pull the body assembly out of the hub (Fig. 8).

Installation

1. Insert the body assembly in the hub.
2. Install the lockring in the groove to retain the body in the hub.
3. Install the snap ring that retains the axle shaft to the body.
4. Position the cap assembly on the body. Install the six Allen-head capscrews and tighten to 4.0-6.0 N·m (40-60 in-lbs).

   NOTE: Do not pack the cap assembly with grease. Excessive grease can cause excessive dialing effort.

Automatic Locking Hubs

Bronco, F-150 (4x4)

Refer to Fig. 9.

Removal:

1. To remove hub, first separate cap assembly from body assembly by removing the five (5) capscrews, using Torx® bit TX25, from the cap assembly.
2. Remove cover.

   CAUTION: Do not drop spring, ball bearing, bearing race, or retainer.
3. Remove rubber seal.
4. Remove seal bridge retainer (small metal stamping) from retainer ring space.
5. Remove retainer ring by closing the ends with needle nose pliers while pulling hub lock from wheel hub.

If wheel hub and spindle are to be removed:

6. Remove C-washer from stub shaft groove.
7. Remove splined spacer from shaft.
8. Remove wheel bearing lock nuts and lock washer.
9. If the hub assembly requires cleaning, refer to Steps 10-13.
10. Wash the cap bearing, race and retainer assembly in cleaner solvent and thoroughly dry the components. Repack the bearing with a lithium base grease, Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Refer to Figs. 10

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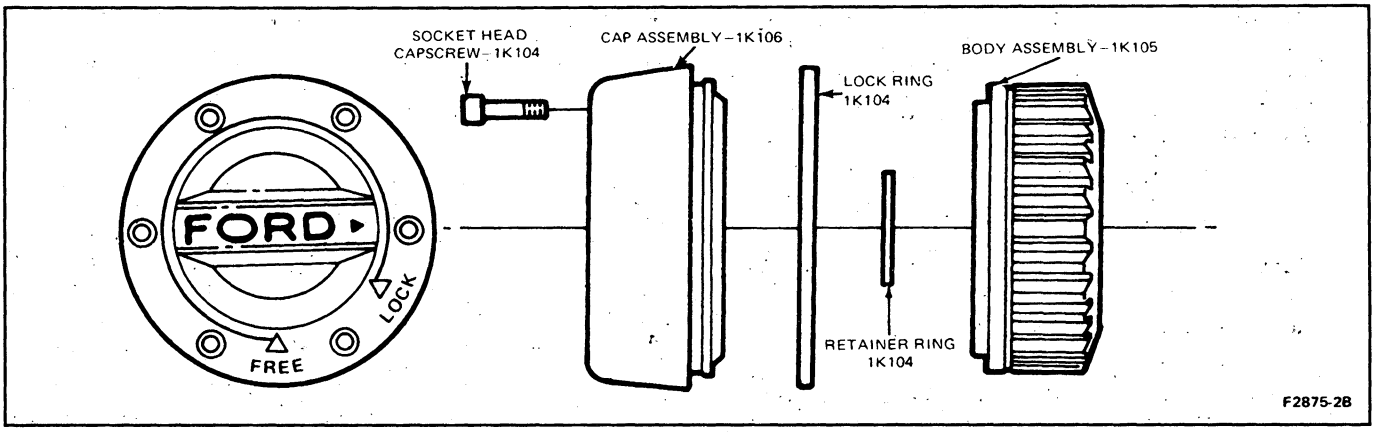


FIG. 4 Manual Locking Hubs (Warner)—Bronco, F-150—F-350 (4x4)

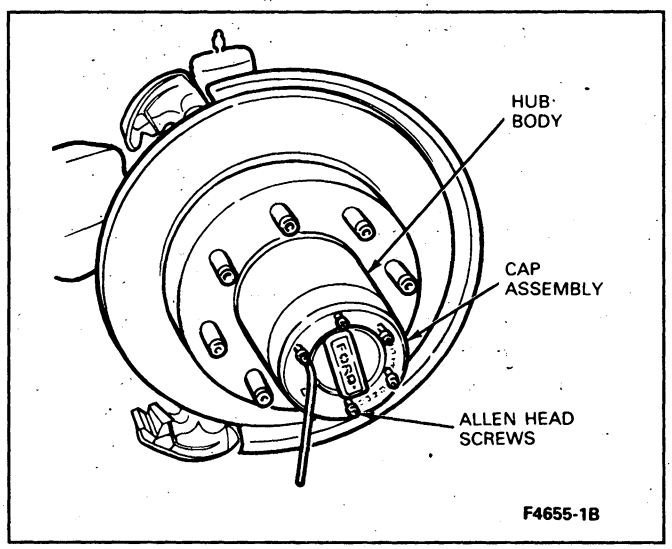


FIG. 5 Cap Removal—Manual Locking Hub

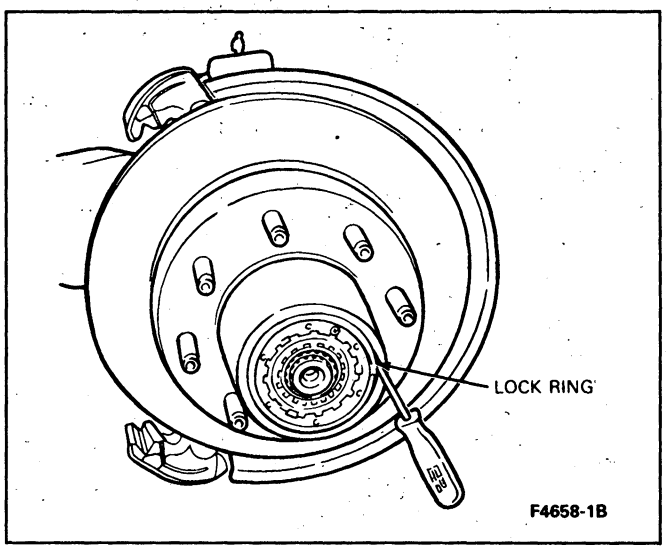


FIG. 7 Lockring Removal—Manual Locking Hub

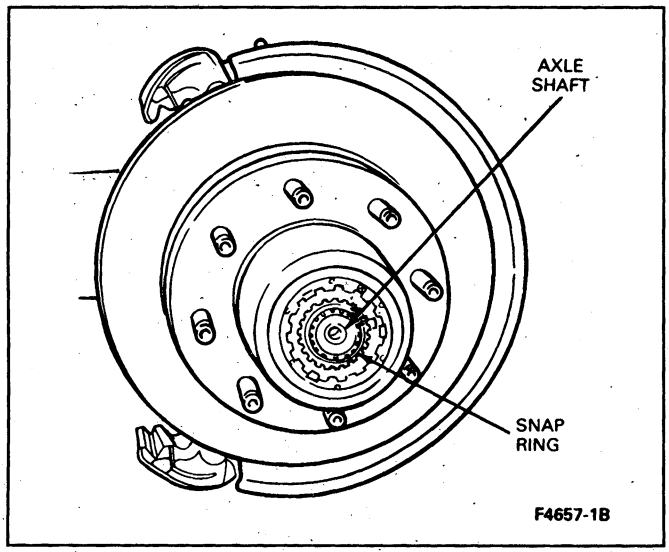


FIG. 6 Snap Ring Removal—Manual Locking Hub

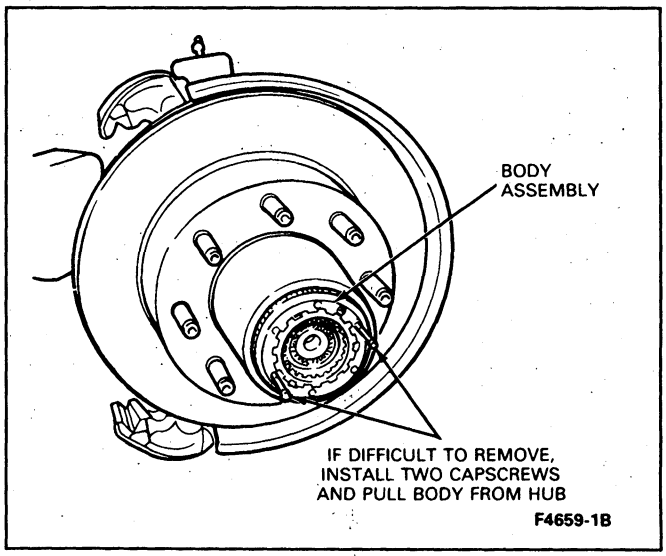


FIG. 8 Body Removal—Manual Locking Hub

and 11 for proper positioning of the bearing on the race.

11. Remove the snap ring and flat washer (Fig. 12) from the inner end of the hub lock assembly. Pull the hub sleeve and attached parts out of the drag sleeve, then cock the drag sleeve to unlock the tangs of the brake band and remove the drag sleeve assembly (Fig. 13). (NOTE: Never remove the brake band from the drag sleeve). Wash in cleaner solvent and air dry the drag sleeve and

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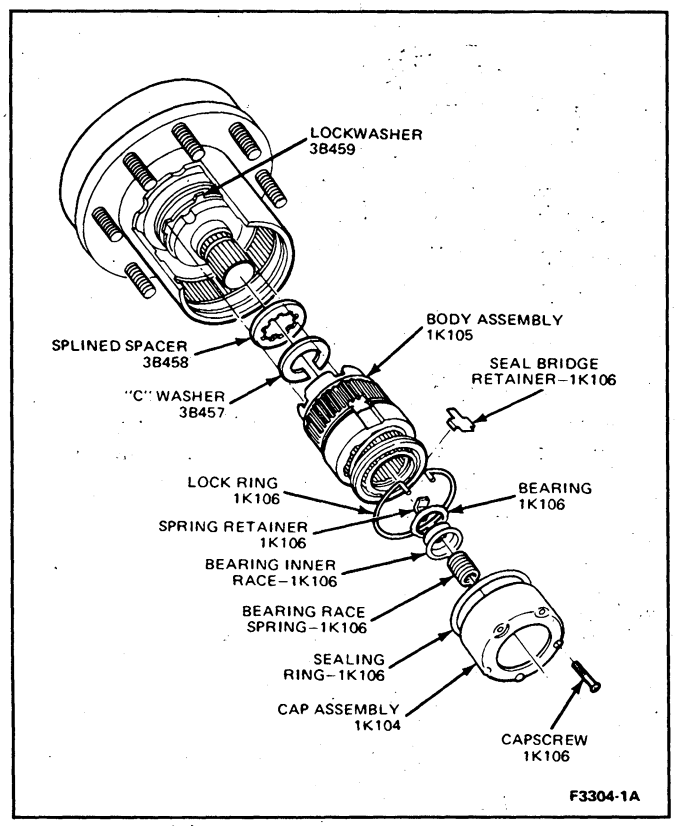


FIG. 9 Automatic Locking Hub (Warner)—Exploded View

brake band. Lubricate the brake band and drag sleeve assembly with 1.5 grams (0.05 oz.) of Automatic Hublock Grease, E1TZ-19590-A (ESL-M1C193-A) (Darmex Spec. DX-123-LT.) or equivalent. Work the lubricant over the spring and the area of the drag sleeve under the spring.

12. The body assembly (excludes cap assembly, and brake band and drag sleeve assembly) should be dipped in Automatic Transmission Fluid-MERCON® XT-2-QDX or equivalent and permitted to drip dry for a few minutes before proceeding with re-assembly.
13. Assemble one of the two tangs of the brake band on each side of the plastic outer cage which is located in the window of the steel inner cage. It will be necessary to cock these parts to engage the tangs in this position as the drag sleeve is positioned against the face of the cam follower (Fig. 14). Install the washer and snap ring (Fig. 12).

Installation

1. Wheel bearing locknut and lockwasher installation is the same as with manual hub locks except for tightening the outside wheel bearing locknut to 203 N·m (150 ft-lb).
2. Install the splined spacer and the C-washer on the axle shaft.

NOTE: Remove excessive grease from hub-lock and hub splines prior to installation.

3. Start hub lock assembly into hub making sure the large tangs are lined up with the lock washer and the outside diameter and inside diameter splines are in line with the hub and axle shaft splines.

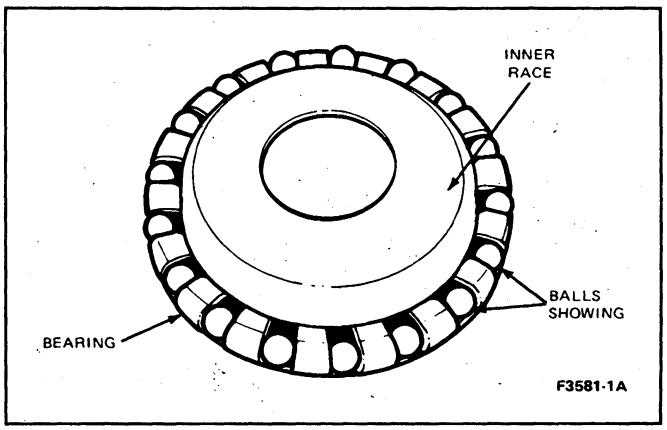


FIG. 10 Bearing Over Inner Race Installation

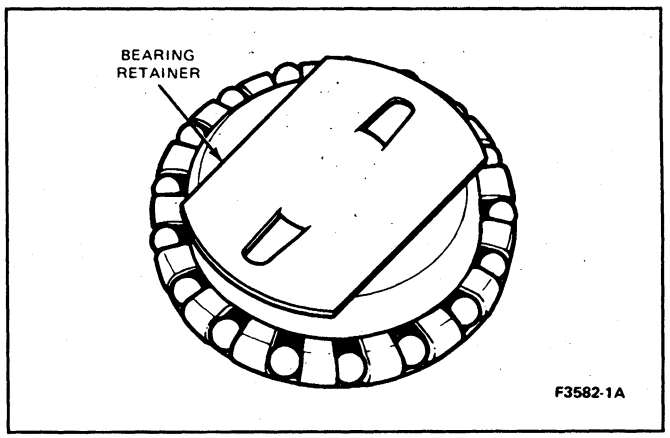


FIG. 11 Bearing Retainer Installation

4. Install retainer ring by closing the ends with needle nose pliers and at the same time push hub lock assembly into the hub.
5. Install seal bridge retainer (small metal stamping) with narrow end first.
6. Install rubber seal over hub lock.
7. Install cover (make sure ball bearing, spring, bearing race and retainer are in place).
8. Tighten the 5 screws to 4.5-5.6 N·m (40-50 in-lb) using Torx® Bit TX25 in following sequence: tighten one, skip one, etc.

DISASSEMBLY AND ASSEMBLY

Front Wheel Grease Seal and Bearing Replacement and Repacking

Bronco and F-150, F-250, F-350 (4x4)

The recommended wheel bearing lubricant is the lithium-base grease, Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

Sodium-base grease is not compatible with lithium-base grease and should not be intermixed. Therefore, before lubricating front and/or rear wheel bearing, **note which type was used as the original wheel bearing lubricant.** Usage of incompatible bearing lubricant could result in premature lubricant breakdown.

If bearing adjustment does not eliminate looseness or rough and noisy operation, clean, inspect and repack the hub and bearings with specified wheel grease. If

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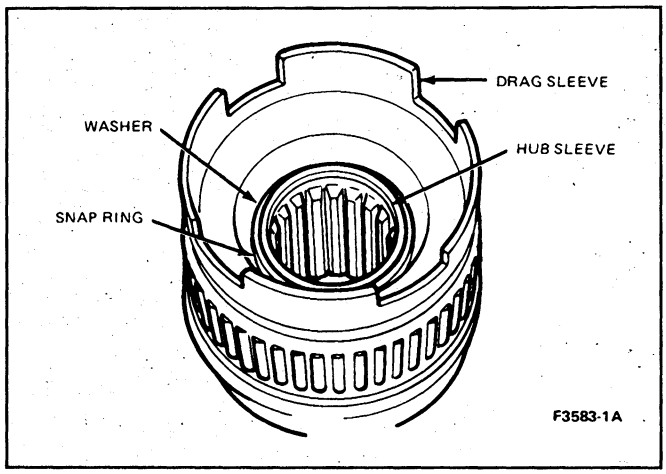


FIG. 12 Washer and Snap Ring

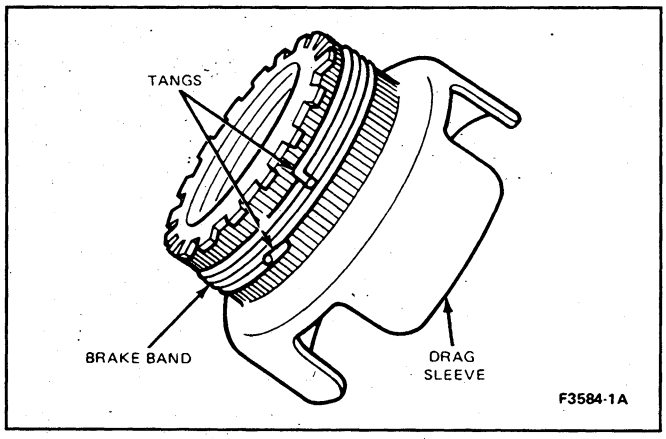


FIG. 13 Drag Sleeve and Brake Band

bearing cups or the cone and roller assemblies are worn or damaged, they should be replaced.

Disassembly

1. Raise the vehicle and install safety stands.
2. If equipped with locking hubs, refer to Manual or Automatic Locking Hub Removal and Installation, this Section and remove the locking hub.
3. Remove the wheel lug nuts and the wheel and tire from the hub and rotor assembly as described in Section 11-02, Wheel and Tires.
4. For Bronco and F-150—F-250 (4x4) vehicles equipped with Dana Model 44 front drive axle and manual hub lock, remove the adjusting nut with Spanner Locknut Wrench, T86T-1197-A. Apply inward pressure on the Locknut Wrench to disengage the adjusting nut locking splines and turn the nut counter-clockwise to loosen and remove the nut from the spindle. For F-150 with automatic hub locks—F-250—F-350 (4x4) vehicles equipped with Dana Model 50, 44 and Model 60 Monobeam front drive axles, remove the outer locknut, lockwasher and inner locknut with Spanner Locknut Wrench D85T-1197-A (Figs. 3 and 15).
5. Remove the brake caliper (refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper) and wire it to the frame to prevent damage to the brake hose. Do not let the caliper hang only by the brake hose to prevent damage to the hose or the caliper.
6. Remove the hub and disc assembly. The outer wheel bearing cone and roller assembly will slide out as the hub is removed (Fig. 16).
7. Remove the spindle retaining nuts, then carefully remove the spindle from the knuckle studs and axle shaft.
8. Clean all old grease from the needle bearings and the spindle bore seal.
9. Clean any old grease or dirt from these parts and replace if signs of excessive wear are noted.

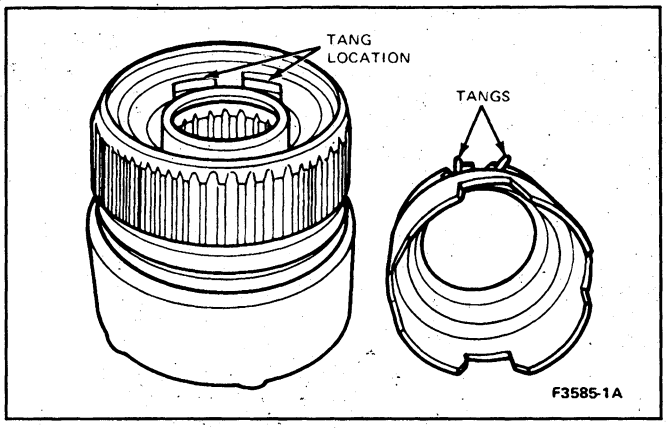


FIG. 14 Brake Band and Drag Sleeve Assembly to Body Assembly Installation

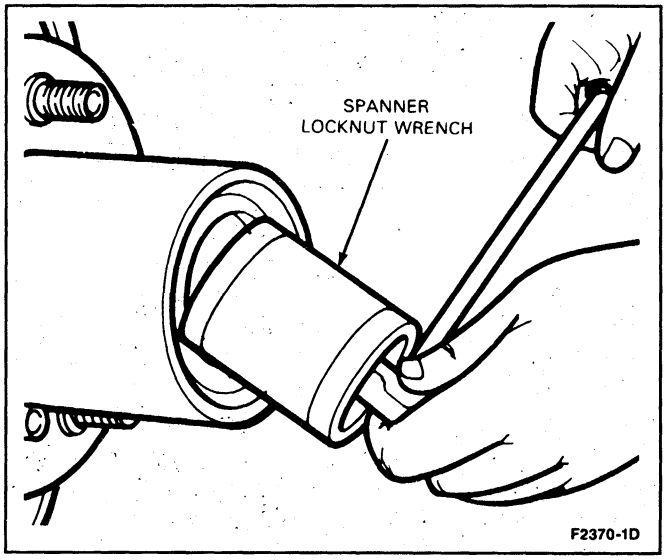


FIG. 15 Locknut, Lock Ring and Adjusting Nut Removal

Assembly

1. Using Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent, thoroughly lubricate the needle bearing and pack the spindle face that mates with the spindle bore seal.
2. Assemble the spindle over the axle shaft onto the knuckle studs. On F-350, adjust the retaining nuts to 68-81 N·m (50-60 ft-lb). On F-150—F-250 and Bronco, adjust the retaining nuts to 27-41 N·m (20-30 ft-lb).

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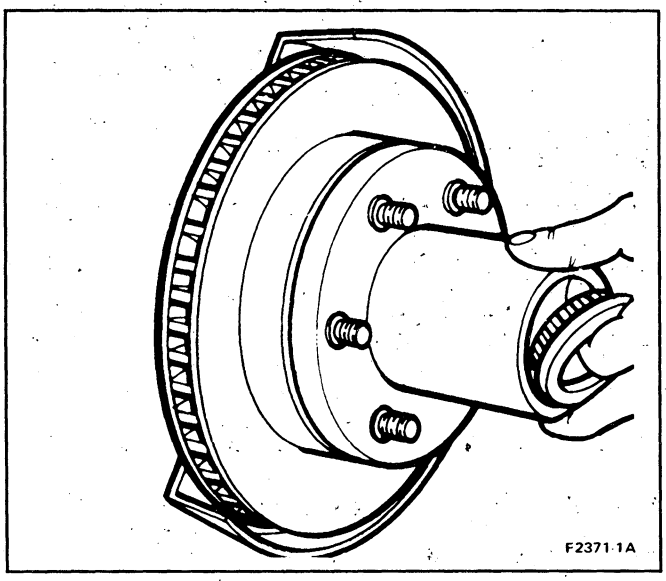


FIG. 16 Hub, Disc, and Outer Bearing Removal

3. Remove the inner bearing cone and grease seal and bearing cups from the hub using Bearing Cup Puller, T77F-1102-A and Impact Slide Hammer, T50T-100-A or equivalent.
4. Inspect the bearing cups for pits or cracks. If necessary, remove them with a drift. **If new cups are installed, install new cone and roller assemblies.**
5. Lubricate the bearings with Long Life Lubricant C1AZ-19590-BA, (ESA-MIC75-B) or equivalent. Clean all old grease from the hub. Pack the cones and rollers. If a bearing packer is not available, work as much lubricant as possible between the rollers and the cages.
6. Position the inner bearing cone and roller in the inner cup and install the grease seal.
7. Carefully position the hub and disc assembly on the spindle.
8. Install the outer bearing cone and roller, and the adjusting nut or locknuts and lockwashers.

NOTE: On Dana Model 44 Front drive axles, the metal stamping on the adjusting nut must face inboard (towards the spindle). Make sure the inner diameter key on the nut enters the spindle keyway.

9. Adjust the wheel bearings as described in this Section under Adjustments.
10. Install tire and wheel as described in Section 11-02, Wheels and Tires.
11. Install the locking hubs as described in this Section under Removal and Installation.
12. Remove the safety stands and lower the vehicle.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lb.	Universal
T59L-100-B	Impact Slide hammer — 2-1/2 Lb.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lb.	Universal
T58L-101-B	Puller Attachment	Universal — Use with Slide Hammer
D80L-927-A	Wheel Hub Cap Remover	Universal
T77F-1102-A	Bearing Cup Puller	Universal — Use with Slide Hammer
TOOL 1175-AC	Seal Remover	Universal — Use with Slide Hammer
D85T-1197-A	Spanner Locknut Wrench	Dana Model 50 IFS and Model 60 Monobeam Front Drive Axles
T86T-1197-A	Spanner Locknut Wrench	Dana Model 44 IFS Front Drive Axle
D78P-1225-B	Bearing Cup Puller	Universal
D79T-4000-A	Outside Thread Chaser	Universal
T80T-4000-W	Driver Handle	Bearing Installation

CE-4329-2F

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2D

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SECTION 11-14 Wheel Hubs and Bearings—Rear DANA Full Floating Axle

SUBJECT	PAGE
ADJUSTMENTS	11-14-1
DESCRIPTION	11-14-1
DISASSEMBLY AND ASSEMBLY	
Bearings, Cups and Seals	11-14-1
SPECIFICATIONS	11-14-7
VEHICLE APPLICATION	11-14-1

VEHICLE APPLICATION

HD E-250 Through E-350 DRW, F-Super Duty and F-Super Duty Stripped Chassis Vehicles.

DESCRIPTION

On HD E-250—E-350 full-floating rear axle wheel hubs with tapered roller bearings, a seal is installed behind the inner bearing to keep the wheel bearing lubricant from the brake lining and brake drum (Figs. 1 and 2). The F-Super Duty axle is disc brake-equipped (Fig. 3) and contains larger tapered roller bearings and a unique inner seal and shaft-hub gasket.

The wheel bearings are packed with a lithium base grease, Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent to provide initial lubrication until axle lubricant flows into the wheel hubs and bearings during vehicle operation. On these axles the wheel hub is vented through the axle housing vent hose in the LH axle tube.

Vehicles equipped with dual rear wheel (DRW) axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts (Fig. 1).

WARNING: ON REAR AXLES WITH DUAL REAR WHEELS DO NOT ATTEMPT TO USE PRE-1985 LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

ADJUSTMENTS

For rear wheel bearing adjustments refer to bearings, cups and seals under Disassembly and Assembly in this Section.

DISASSEMBLY AND ASSEMBLY

Bearings, Cups and Seals

HD E-250—E-350

Vehicles equipped with dual rear wheel (DRW) axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PRE-1985 LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

Disassembly

1. Set the parking brake and **loosen** the axle shaft attaching bolts (Fig. 1).
2. Raise the rear wheels off the floor and place safety stands under the rear axle housing so that the axle is parallel with the floor. Release parking brake and back off the rear brake adjustment, if necessary.
3. Remove the axle shaft attaching bolts and lock washers and discard them.
4. Using a heavy duty wheel dolly such as the Rotunda model 014-00030 or equivalent as shown in Fig. 4, raise the wheel to the point that all weight is removed from the wheel bearings.
5. Remove brake drum. If so equipped, push-on sheet metal drum retainer nuts may be discarded.
6. Remove the axle shaft and discard the gasket.
7. Remove the wheel bearing hub nuts using Hub Wrench T85T-4252-AH so the drive tangs of the tool engage the four slots in the hub nut (Fig. 5).
8. Remove the outer bearing cone, pull the wheel assembly straight out and away from the axle. If it had not been done in step 4, remove hub assembly and set aside.

CAUTION: The hub nuts are right hand (thread on the right spindle) and left hand (thread on the left spindle). Each hub nut is stamped RH or LH to

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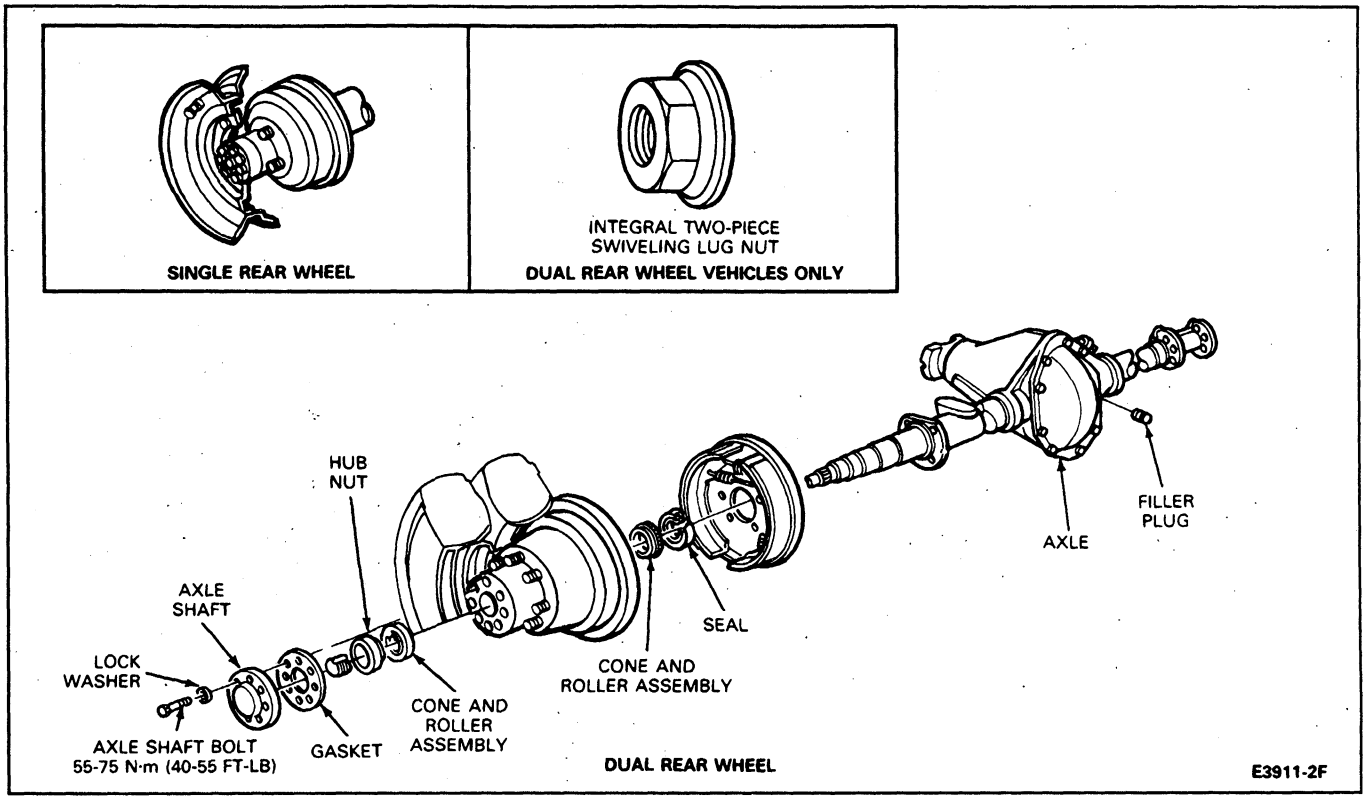


FIG. 1 Rear Wheel Hub—Dana Full-Floating Axle HD E-250—E-350

identify thread direction. Do not use power impact tools when performing operations on the hub nuts (Fig. 6).

NOTE: The hub nuts will ratchet during this operation, unless the tool for the F-Super Duty is used, Tool T88T-4252-A.

9. Thoroughly clean the spindle of the axle housing.
10. Carefully remove inner seal from hub assembly with screwdriver, avoiding damage to the bearing or hub bore. Discard the seal.
11. Clean all old grease and axle lubricant out of the wheel hub.
12. Inspect the bearing races and rollers for pitting, galling or erratic wear patterns. Inspect the rollers for end wear (Fig. 7).
13. Remove the bearing cups by driving them out with a brass drift. Inspect the cups for galling or excessive wear. If either component (cup or cone and roller) of the tapered roller bearing is not usable, both components should be replaced. Install the new cups with special tool Bearing Cup Replacer T75T-1225-A or B and Threaded Drawbar T75T-1176-A (Fig. 8).

Assembly

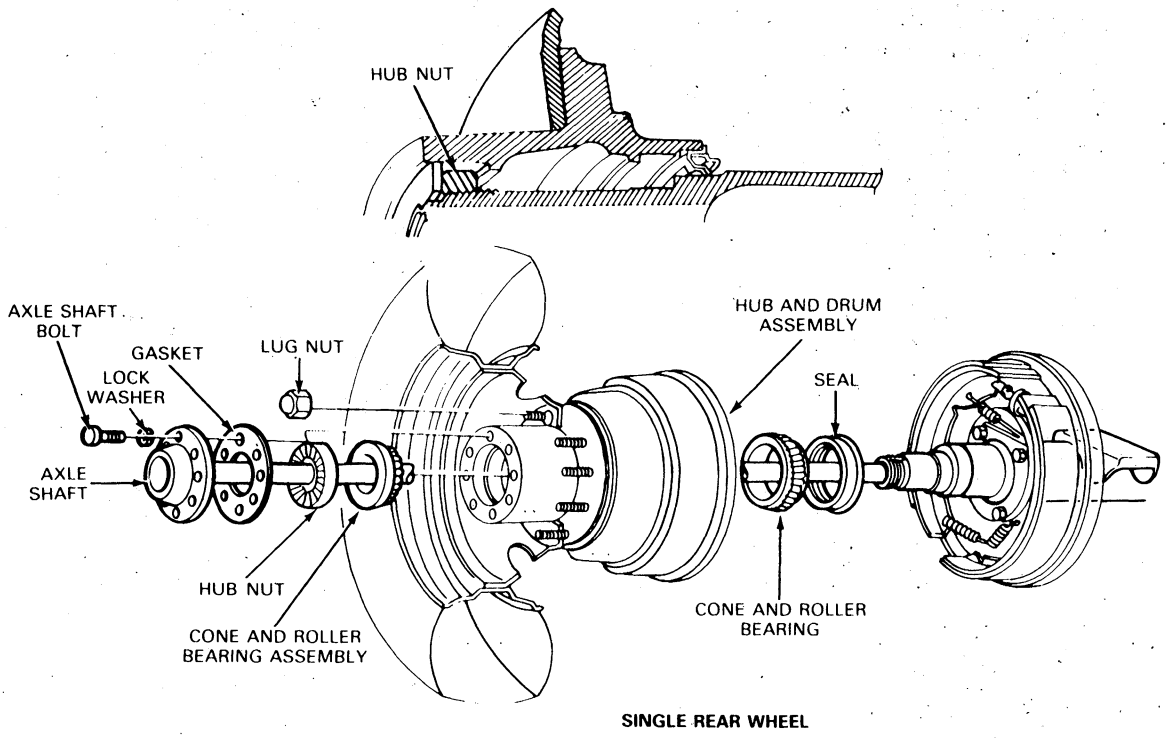
1. Check for proper seating of the new bearing cups by trying to insert a 0.038 mm (0.0015 inch) feeler gauge between the cups and the wheel hub. The gauge should not enter beneath the cup. Check several places to make sure that the cups are squarely seated.
2. Pack each bearing cone and roller assembly with a lithium base grease Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Use a bearing packing tool such as Rotunda 108-00078 or equivalent.
3. Place the inner bearing cone and roller assembly in the wheel hub. Install a new hub inner seal with Replacer Tool, T75T-1175-B and Threaded Drawbar, T75T-1176-A (Fig. 7).
4. Position the hub assembly at the axle housing. Wrap the threads of the spindle with electricians tape. **Carefully slide the hub assembly straight (to avoid seal damage) onto the axle housing spindle.** Remove the electricians tape.
5. Install the outer wheel bearing cone and roller and start the bearing hub nut making sure the hub tab is properly located in the keyway prior to thread engagement (Fig. 9).
6. Install Hub Wrench Tool T85T-4252-AH so the drive tangs of the tool engage the four slots in the nut (Fig. 9). Install torque wrench and tighten hub nut to 88-102 N·m (65-75 ft-lb). Rotate hub occasionally while tightening to set bearings.

NOTE: Hub will ratchet as torque is applied.

The hub wrench for the F-Super Duty can be used in place of Tool T85T-4252-AH. The F-Super Duty tool has tangs 0.3 inches long and when fully engaged by applying inward pressure it will disengage the ratcheting mechanism in the nut. Eliminating ratcheting will provide more even bearing preloads, and will optimize bearing life.

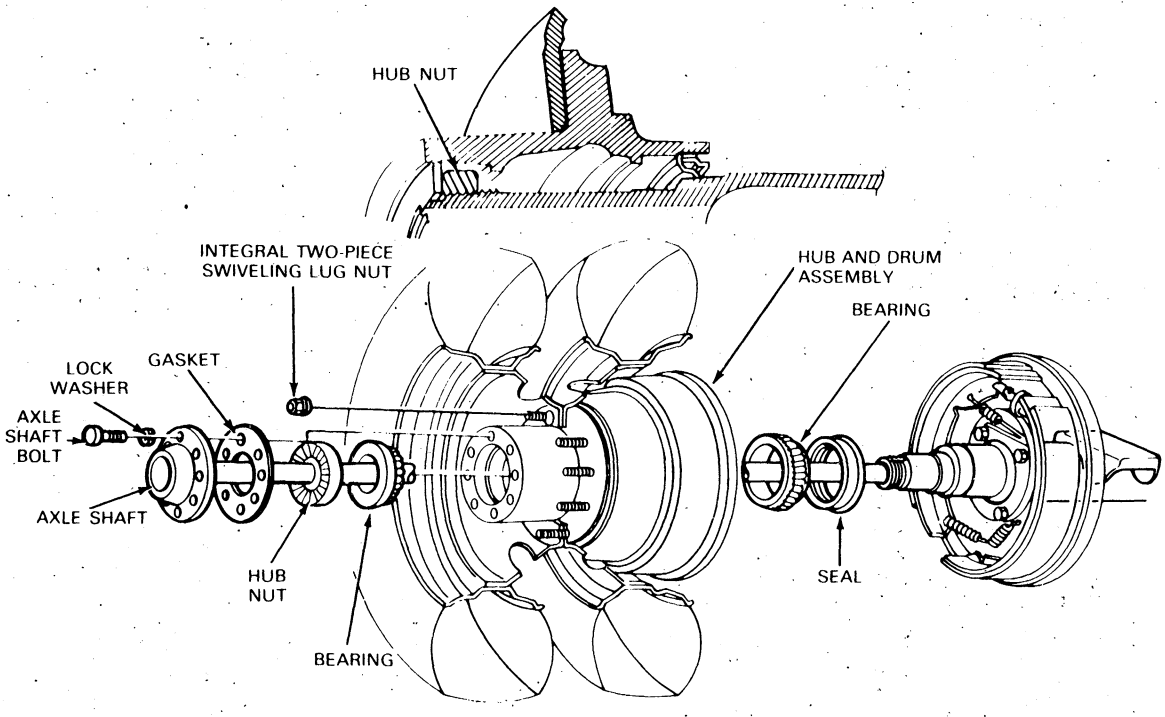
7. After tightening to specification, ratchet back 90 degrees, then tighten to 20-27 N·m (15-20 ft-lb).
8. Prior to reinstallation of the axle shaft, clean and remove any metallic debris in the hub bolt holes. Also inspect for cracked material around the holes, depth of the threaded hole (minimum 25.4 mm or 1

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SINGLE REAR WHEEL

SINGLE REAR WHEEL HUB HD E-250 - E350



DUAL REAR WHEEL - E-350

F1874-2N

FIG. 2 Rear Wheel Hub—Dana Full Floating Axle—HD E-250—E-350

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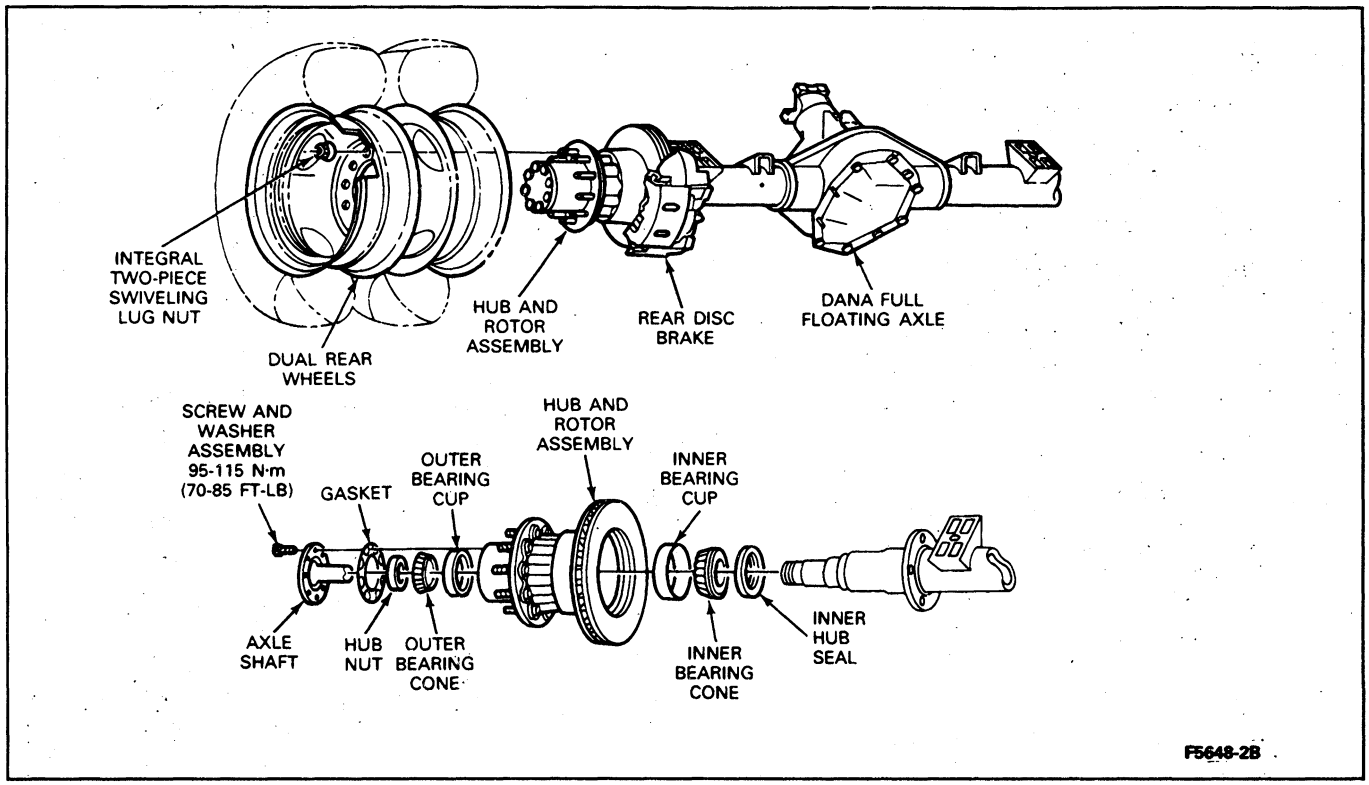


FIG. 3 Rear Wheel Hub—Dana Full Floating Axle F-Super Duty Series Vehicles

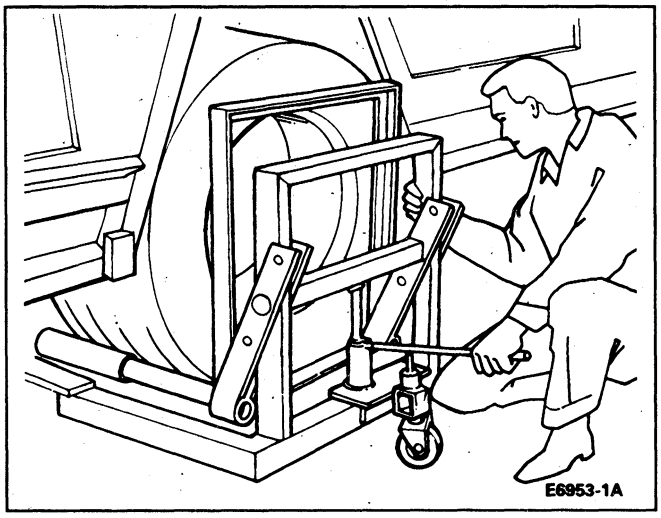


FIG. 4 Heavy Duty Wheel Dolly—014-00030

inch) and oversized threaded holes, and replace hub if any of these conditions are present. Install the axle shaft and new axle flange gasket, lock washers and new axle shaft retaining bolts. Coat the bolt thread with a suitable thread adhesive. Tighten the bolts until they seat.

9. Install the brake drum.
10. Install the wheel and tire assembly.
11. Lower vehicle after removing safety stands.
12. Adjust the brakes.
13. Tighten wheel lug nuts to specification.
14. Tighten axle shaft retaining bolts to 55-75 N·m (40-55 ft-lb).

Bearings, Cups and Seals

F-Super Duty and F-Super Duty Stripped Chassis Vehicles

Disassembly

1. Set the parking brake and loosen the axle shaft attaching bolts (Fig. 3).
2. Raise the rear wheels off the floor and place safety stands under the rear axle housing. Release the parking brake.
3. Remove the axle shaft attaching bolts and washers and discard them.
4. Using a heavy duty wheel dolly such as the Rotunda Model 014-00030 or equivalent as shown in figure 4, raise the wheel to the point that all weight is removed from the wheel bearings. If a dolly is unavailable, remove the wheel and tire assembly.
5. Remove the axle shaft and discard the gasket.
6. Remove the caliper as outlined in section 12-24.
7. Remove the wheel bearing hub nuts using Tool T88T-4252-A, so that the drive tangs of the socket engage the four slots of the nut (Fig. 5).
8. Remove the outer bearing cone, pull the wheel assembly straight out and away from the axle. If it had not been done in step 4, remove hub assembly and set aside.

CAUTION: The hub nuts are right hand thread for the right side and left hand thread for the left side. Each hub nut is stamped RH or LH to identify thread direction. Do not use power impact tools when performing operations on the hub nuts.

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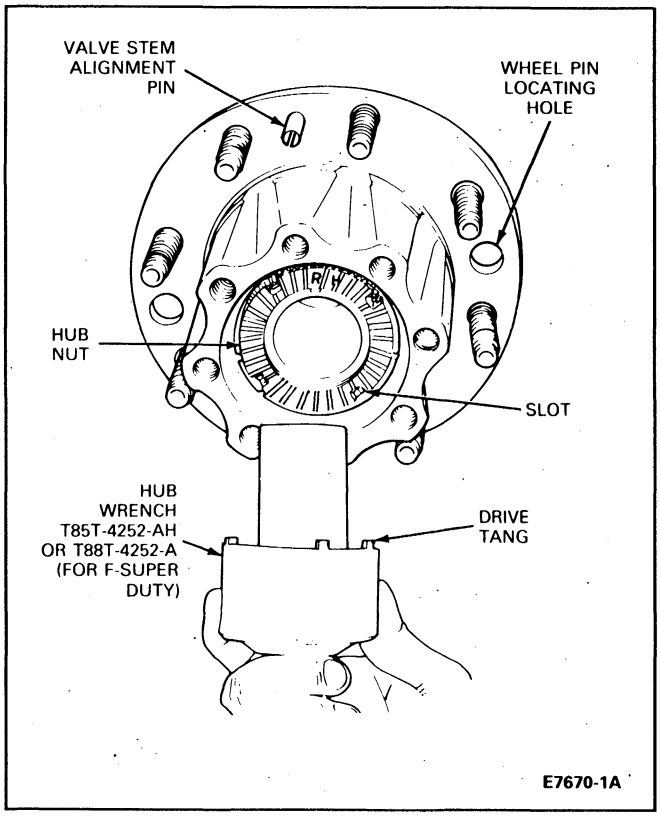


FIG. 5 Hub Wrench Engagement

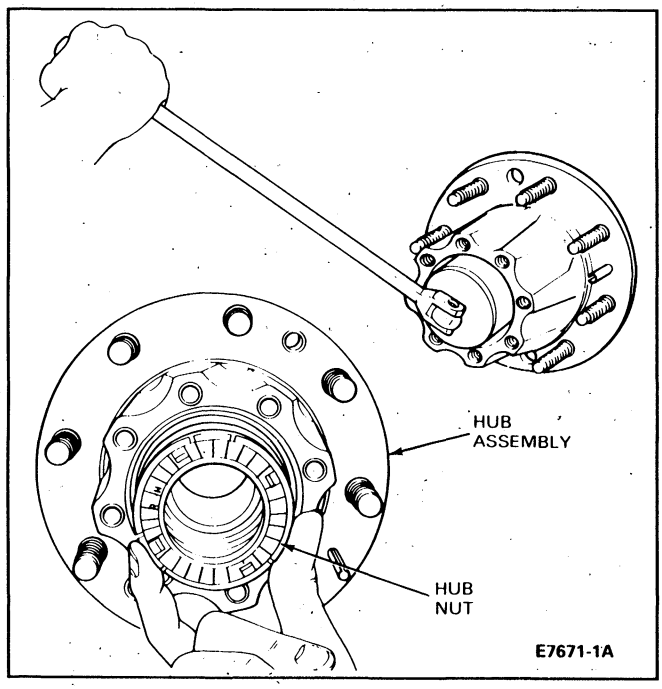


FIG. 6 Tightening Hub Nut

NOTE: The hub nuts will ratchet during this operation unless the F-Super Duty tool is used.

9. Thoroughly clean the spindle of the axle housing.
10. Carefully remove the inner seal from the hub assembly with a screwdriver, avoiding damage to the bearing or hub bore. Discard the seal.
11. Clean all old grease and axle lubricant out of the wheel hub.

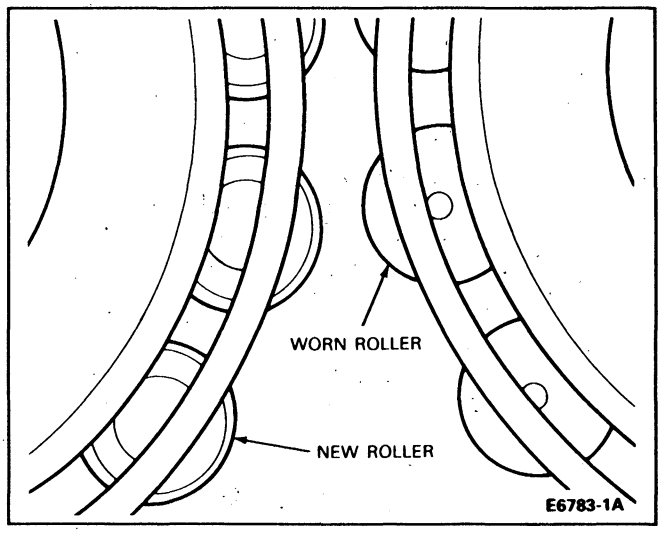


FIG. 7 Roller Bearing End Wear

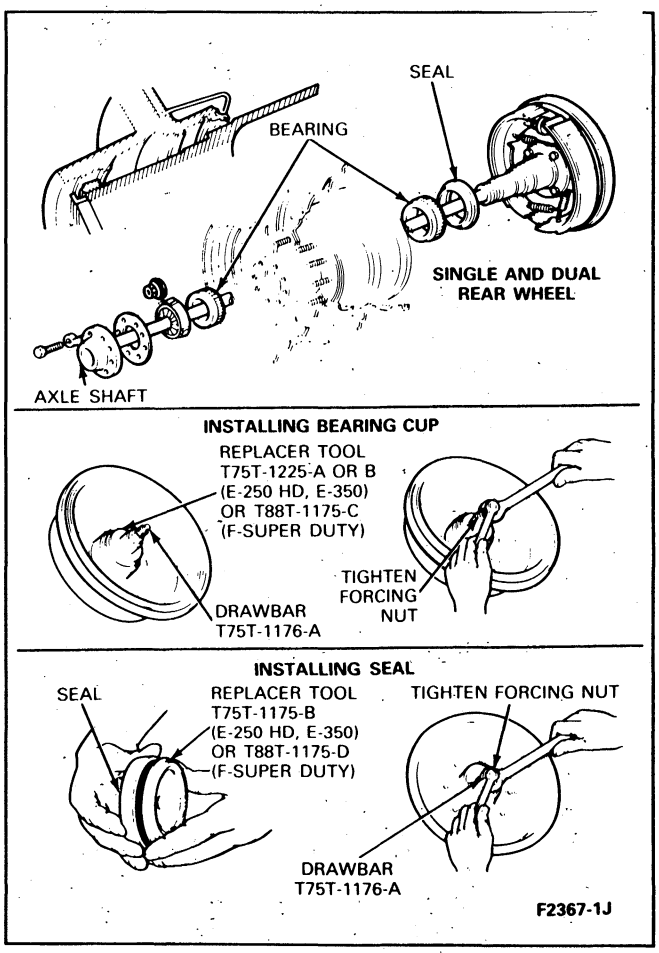


FIG. 8 Installation of Rear Wheel Bearings and Seal

12. Inspect the bearing races and rollers for pitting, galling or erratic wear patterns. Inspect the rollers for end wear (Fig. 7).
13. Remove the inner bearing cup with Tool T88T-1175-B. Remove the outer bearing cup with Tool T88T-1175-A. Inspect the bearing races and rollers for pitting, galling or excessive wear. If either component (cup or cone and roller) of the tapered roller bearing is not usable, both components

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should be replaced. Install the new cups with special tool Bearing Cup Replacer T88T-1175-C and Threaded Drawbar T75T-1176-A (Fig. 8).

Assembly

1. Check for proper seating of the new bearing cups by trying to insert a 0.038mm (0.0015 inch) feeler gauge between the cups and the wheel hub. The gauge should not enter beneath the cup. Check in several places to be sure the cups are squarely seated.
2. Pack each bearing cone and roller assembly with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Use a bearing packing tool such as Rotunda 108-00078 or equivalent.
3. Place the inner bearing cone and roller assembly in the hub. Install a new inner seal with Tool T88T-1175-D and threaded drawbar, T75T-1176-A (Fig. 8).
4. Position the hub and rotor assembly at the axle housing. Wrap the threads of the spindle with electricians tape. Carefully slide the hub and rotor assembly over the axle housing spindle. Remove the electricians tape.
5. Install the outer wheel bearing cone and roller and start the bearing hub nut making sure the hub tab is properly located in the keyway prior to thread engagement (Fig. 9).
6. Install the F-Super Duty Hub Wrench T88T-4252-A so that the drive tangs of the tool engage the four slots of the nut. Apply inward pressure to the socket to separate the ratcheting components of the nut, tighten to 88-102 N·m (65-75 ft-lb). Back off 90 degrees, then re-tighten to 20-27 N·m (15-20 ft-lb). Rotate hub occasionally while tightening to set the bearings.
7. Prior to installation of the axle shaft, clean and remove any debris in the hub bolt holes. Inspect for cracked material around the holes, depth of the holes (40mm total, threaded for 25mm), or oversized holes. Replace the hub if any of these conditions are present. Install the axle shaft, new gasket, and new bolts. Coat the bolt threads with a suitable thread adhesive, and install the bolts until they seat.
8. Install the wheel and tire assemblies.
9. Remove safety stands and lower the vehicle to the floor.
10. Tighten the wheel lug nuts to specifications.
11. Tighten the axle shaft hub retaining bolts to 95-115 N·m (70-85 ft-lb).

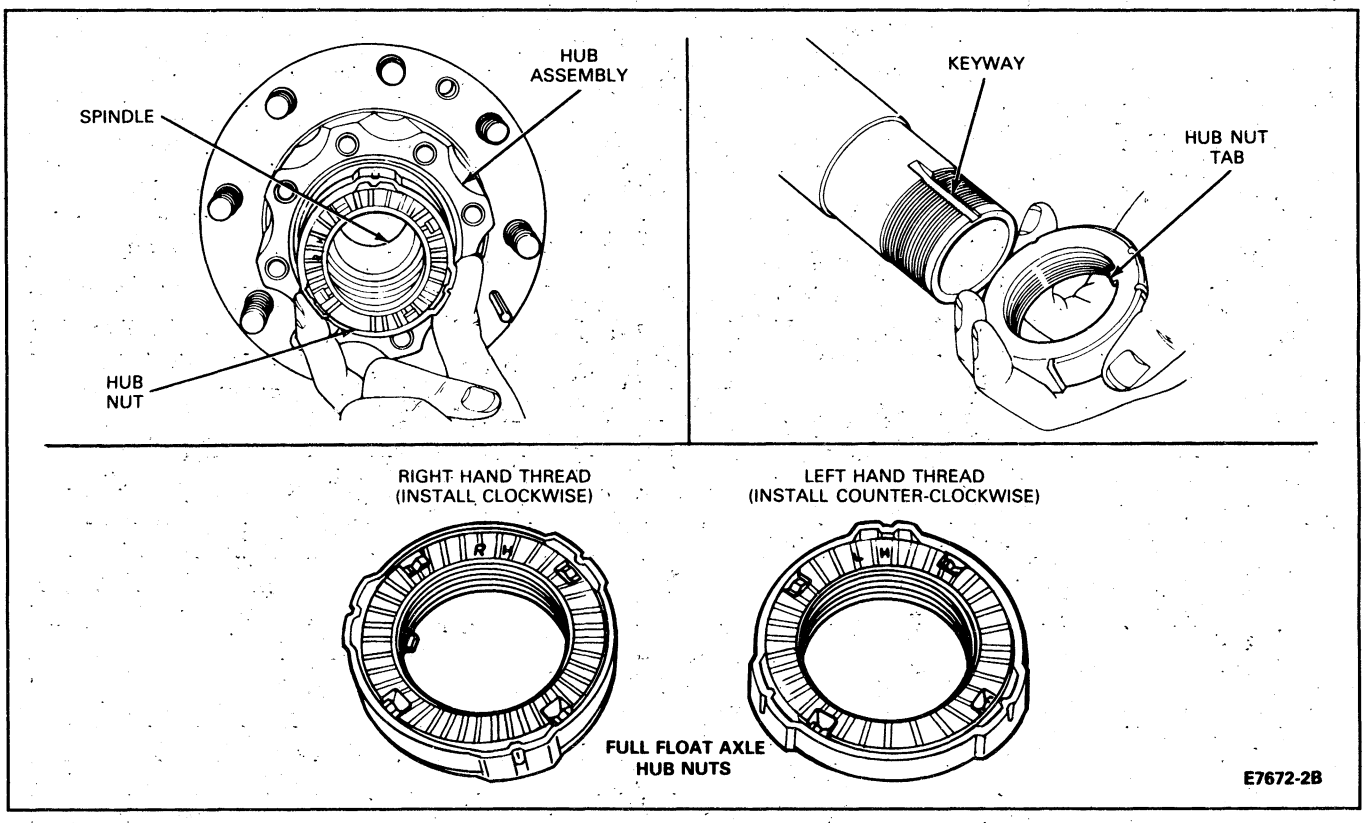


FIG. 9 Hub Nut Installation

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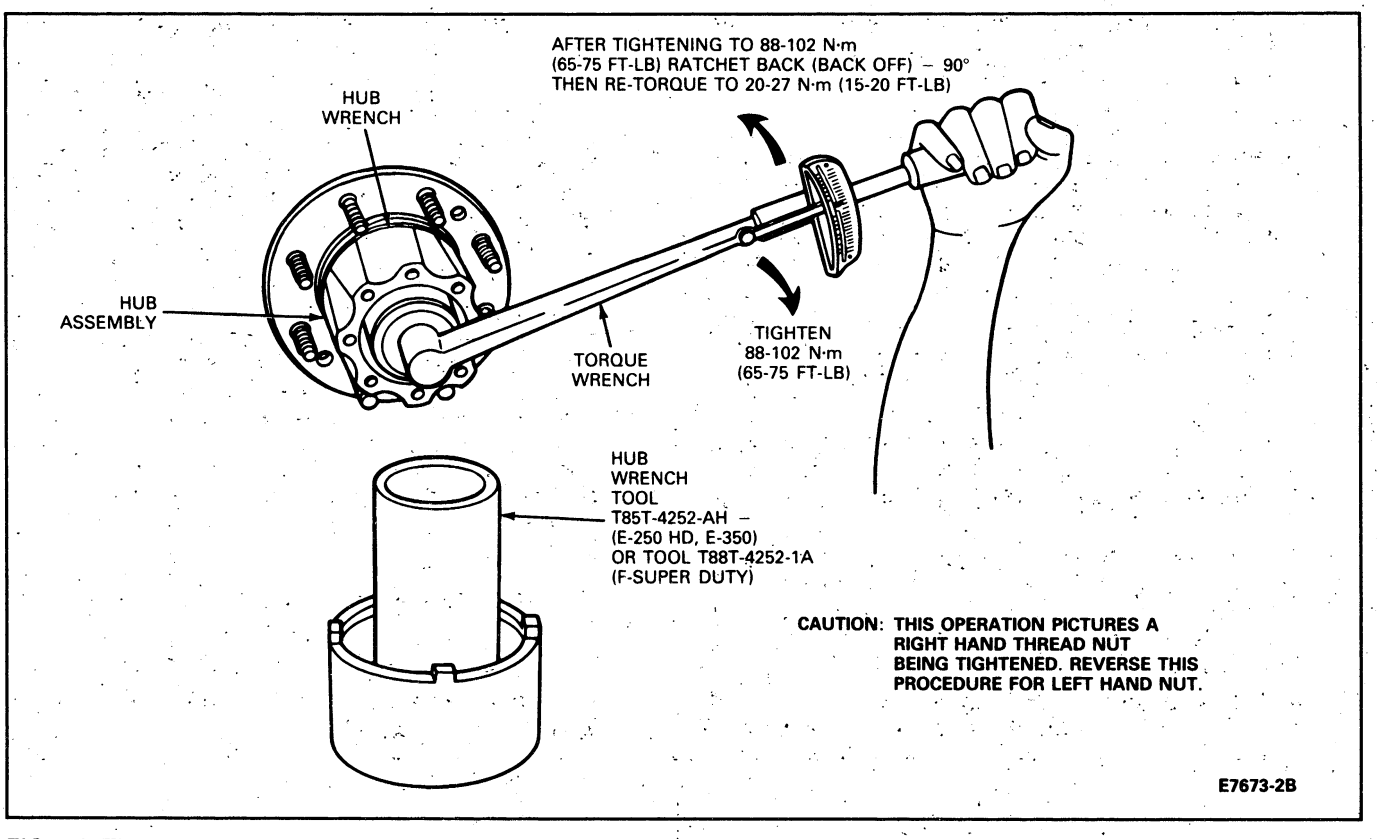


FIG. 10 Tightening Hub Nut

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lb.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lb.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lb.	Universal
T58L-101-B	Puller Attachment	Universal — Use with Slide Hammer
T77F-1102-A	Bearing Cup Puller	Universal — Use with Slide Hammer
TOOL-1175-AC	Seal Remover	Universal
T75T-1175-A	Seal Replacer	Use with Threaded Drawbar
T75T-1175-B	Seal Replacer	Use with Threaded Drawbar
T75T-1176-A	Threaded Drawbar	—
T73T-1202-A	Bearing Cup Replacer	Use with Driver Handle
T75T-1225-A	Bearing Cup Replacer	Use with Threaded Drawbar
T75T-1225-B	Bearing Cup Replacer	Use with Threaded Drawbar
T76T-1225-C	Bearing Cup Replacer	E-350 with DRW
D79T-4000-A	Outside Thread Chaser	Universal
T80T-4000-W	Driver Handle	Bearing Installation
T85T-4252-AH	Hub Wrench	—
T70T-4252-D	2-9/16" Hex Locknut Wrench	—
T70T-4252-E	2-9/16" Octal Locknut Wrench	—
T88T-1175-A	Hub Outer Bearing Cup Remover	F-Super Duty Series Vehicles
T88T-1175-B	Hub Inner Bearing Cup Remover	—
D80T-4200-H	Hub Inner Bearing Cup Replacer	—
T88T-1175-C	Hub Outer Bearing Cup Replacer	—
T88T-1175-D	Hub Seal Replacer	—
T88T-4252-A	Hub Wrench	F-Super Duty Series Vehicles and HDE-250, E-350

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WHEEL TORQUE SPECIFICATIONS — FULL FLOAT REAR AXLES

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-250, E-350 — Single Rear Wheel Vehicles	8-Lug Wheel	9/16-18	190	140
E-350 — Dual Rear Wheel Vehicles With Integral Two-Piece Swiveling Lug Nuts	8-Lug Wheel	9/16-18	190	140
F-Super Duty Series Dual Rear Wheel Vehicles with Integral Two-Piece Swiveling Lug Nuts	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. **CE5841-2D**

ROTUNDA EQUIPMENT

Number	Description
014-00030	Heavy Duty Wheel Dolly
108-00078	Bearing Packer

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GROUP

12 BRAKES

(2000)

SECTION TITLE	PAGE
BRAKE BOOSTER VACUUM PUMP—7.3L DIESEL ENGINE	12-56-1
BRAKE PEDAL, MASTER CYLINDER AND VALVES	12-30-1
DISC BRAKES—LIGHT AND HEAVY DUTY—SLIDING CALIPER	12-24-1
DRUM BRAKES—SINGLE CYLINDER, DUAL PISTON	12-02-1
GENERAL HYDRAULIC BRAKE SERVICE	12-01-1
HYDRO-BOOST BRAKE BOOSTER	12-57-1
PARKING BRAKE—CABLE ACTUATED, REAR WHEELS AND TRANSMISSION MOUNTED	12-70-1
REAR ANTILOCK BRAKES	12-31-1
VACUUM BRAKE BOOSTER—SINGLE DIAPHRAGM—DASH-MOUNTED (BENDIX)	12-50-1
VACUUM BRAKE BOOSTER—TANDEM DIAPHRAGM—DASH-MOUNTED (BENDIX)	12-52-1

SECTION 12-01 General Hydraulic Brake Service

SUBJECT	PAGE
ADJUSTMENTS	
Brake Hose	12-01-17
Brake Pedal Adjustment	12-01-6
Brake Tube	12-01-14
Flaring A Line (Flaring-Bar Type)	12-01-15
Flaring A Line (Split-Die Type)	12-01-14
Dump Valve Adjustment	12-01-9
(Vehicles with Speed Control Only)	12-01-9
Front Disc Brakes	12-01-9
Hydraulic Line Repair	12-01-14
Hydraulic System Bleeding	12-01-9
Pressure Bleeding—Dual Brake System Hydraulic Master Cylinder	12-01-12
Rear Disc Brakes	12-01-9
Rear Drum Brakes	12-01-9
DESCRIPTION AND OPERATION	
Disc Brakes	12-01-2
Drum Brakes	12-01-2
Dual Master Cylinder Brake System	12-01-2
Rear Antilock Brakes	12-01-3
DIAGNOSIS AND TESTING	
A Master Cylinder Bypass Condition—Checking	12-01-5
DIAGNOSIS AND TESTING (Cont'd)	
Brake System Preliminary Checks	12-01-3
Checking Brake System for External Fluid Leaks	12-01-5
Checking for Brake Pedal Reserve	12-01-5
Diagnosis Guides	12-01-6
Dual Brake Warning Light System Tests	12-01-3
Hydraulic Leak Test	12-01-4
Master Cylinder	12-01-5
Power Brake Function Test	12-01-4
Vacuum System Test	12-01-4
OVERHAUL	
Brake Cylinder	12-01-20
Brake Drum Refinishing	12-01-17
Brake Drums and Linings	12-01-20
Front Disc Brakes	12-01-18
Master Cylinder	12-01-20
Rear Disc Brakes	12-01-19
SPECIFICATIONS	12-01-20
VEHICLE APPLICATION	12-01-2

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VEHICLE APPLICATION

E-150-E-350, F-150-F-350, F-Super Duty Chassis Cab, Stripped Chassis, Motor Home Chassis and Bronco Vehicles.

DESCRIPTION AND OPERATION

Hydraulic brakes are standard equipment on all vehicles.

Hydraulic rear drum brakes on all Bronco, F-150—F-350 and E-150—E-350 trucks use automatic rear brake shoe adjusters. Hydraulic disc brakes are used on all front brake systems, and for F-Super Duty series vehicle rear brakes.

Dual Master Cylinder Brake System

Refer to Figures 1, 2 and 3.

The dual master cylinder contains a double hydraulic cylinder with a plastic see through reservoir, (FLI-Fluid Level Indicator), primary and secondary hydraulic pistons.

The dual master cylinder performs in the following manner:

REAR WHEEL BRAKES—the rear wheel brakes are connected to the secondary outlet port and are actuated by the secondary piston assembly.

FRONT WHEEL BRAKES—the front wheel brakes are connected to the primary outlet port (farthest from dash panel) and are actuated by the primary piston assembly.

Both primary and secondary pistons function together.

The hydraulic brake system is assisted by a vacuum booster installed as standard equipment. Information about the vacuum booster is given in Sections 12-50 Vacuum Brake Booster—Single Diaphragm—Dash Mounted (Bendix) and 12-52 Vacuum Brake Booster—Tandem Diaphragm—Dash Mounted (Bendix), and Hydroboost.

The proportioning valve, integral to the master cylinder (Figs. 2 and 3) proportions pressure to the rear system. During heavy brake application, the proportioning valve reduces pressure (By-Pass feature) to the rear brakes to inhibit lock-up.

The Height Sensing Brake Proportioning Valve (Fig. 4) is used on the E-250—E-350 and F-Super Duty Chassis Cab. The height sensing valve regulates rear brake hydraulic pressure when the vehicle is in the empty condition and provides full braking pressure to the rear brakes when the vehicle is carrying a full load.

The valve is located on the number four crossmember (Fig. 5) and is activated through a linkage system that is connected to the rear axle housing cover. Pressure on the lever from the vehicle load will activate the height sensing valve to regulate the hydraulic pressure to apply the rear brakes.

For more information on the Height Sensing Brake Proportioning Valve, refer to Section 12-30, Brake Pedal, Master Cylinder and Valves.

Disc Brakes

All F-150 through F-350 Series, E-150 through E-350 Series, and Bronco are equipped with front disc brakes. F-Super Duty series vehicles are equipped with Four-wheel disc brakes. (Refer to Section 12-24 Disc Brakes—Light and Heavy Duty Sliding Caliper).

Drum Brakes

The rear brakes are drum type with internal expanding shoes. The rear drum brakes are of the single anchor type, mounted to the same anchor, and actuated by one wheel cylinder. The wheel cylinder has two pistons. One piston exerts force against the upper end of the primary shoe; the other piston exerts force against the upper end of the secondary shoe (Fig. 7).

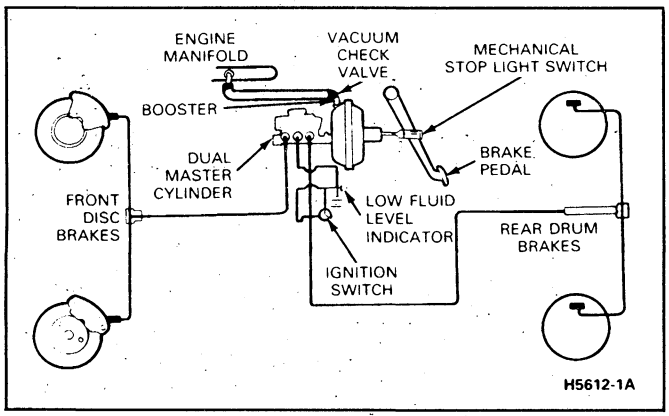


FIG. 1 Hydraulic Brake System with Dash-Mounted Booster—Typical

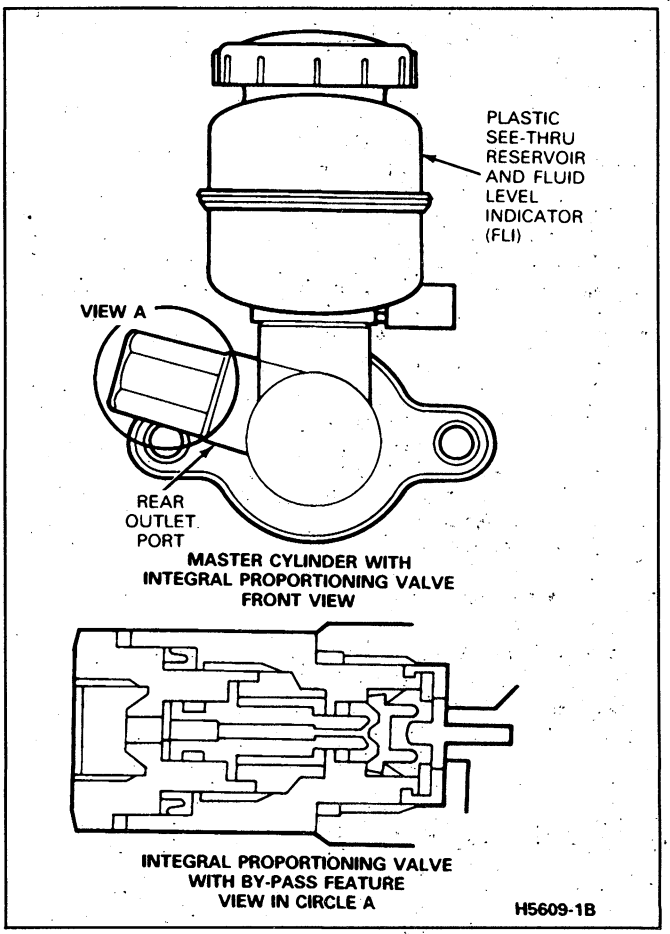


FIG. 2 Master Cylinder Assembly with Integral Proportioning Valve

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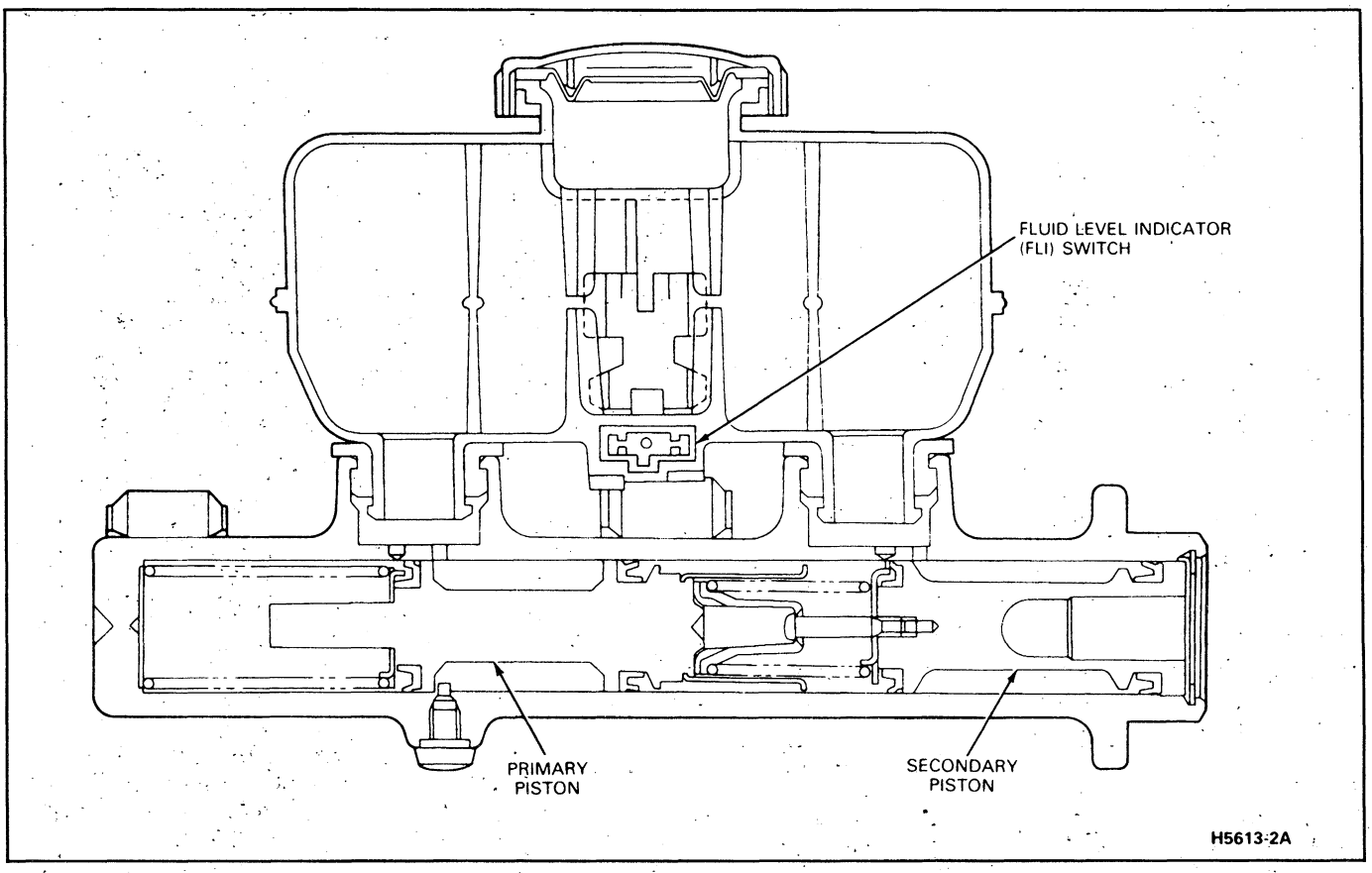


FIG. 3 Master Cylinder Assembly

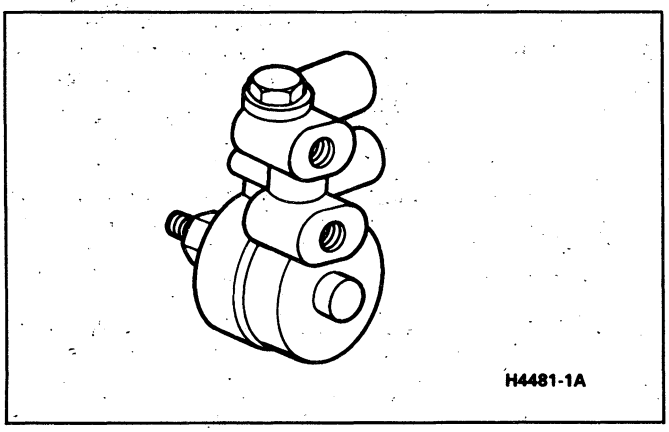


FIG. 4 Height Sensing Brake Proportioning Valve E-250—E-350

Rear Antilock Brakes

The Rear Antilock Brake System (RABS) is used on F-150—F-350 and Bronco vehicles. The system consists of a computer module, RABS Valve speed sensor and an excitor ring. For more information, refer to Section 12-31, Rear Antilock Brakes.

DIAGNOSIS AND TESTING

Occasional brake squeal can be caused by environmental conditions such as cold, hot, wet, snow, salt, mud etc. This occasional squeal is not a functional problem and does not indicate any loss in brake effectiveness.

Brake System Preliminary Checks

Always make the following preliminary checks before testing the brake system:

1. Check the fluid level in the brake master cylinder reservoir(s). If the fluid level is not within 3.17mm (1/8 inch) of the top of the reservoir, add Ford Heavy Duty Brake Fluid, C6AZ-19542-AA or BA (ESA-M6C25-A) or equivalent. **Do not mix low temperature brake fluids with the specified brake fluid.**
2. Push the brake pedal down as far as it will go. If the pedal travels more than halfway to the floor, adjust the rear brakes. The vehicle is equipped with automatic rear brake adjusters, adjust brakes by driving the vehicle forward and backward and applying brakes several times sharply in each direction.
3. If the brakes will apply and the vehicle can be safely stopped, road test the vehicle and apply the brakes at a speed of about 32 km (20 mph) to see if the vehicle stops evenly. If it does not, manually adjust the brakes.

Dual Brake Warning Light System Tests

1. Turn the ignition switch to the ACC or ON position. If the light on the brake warning lamp remains on, there may be a shorted or broken switch, grounded switch wires, or low brake fluid. If the warning lamp still remains on, check for a grounded switch connector or wire and repair or replace the wire assembly. If the wire is in good condition, replace the brake warning lamp switch.

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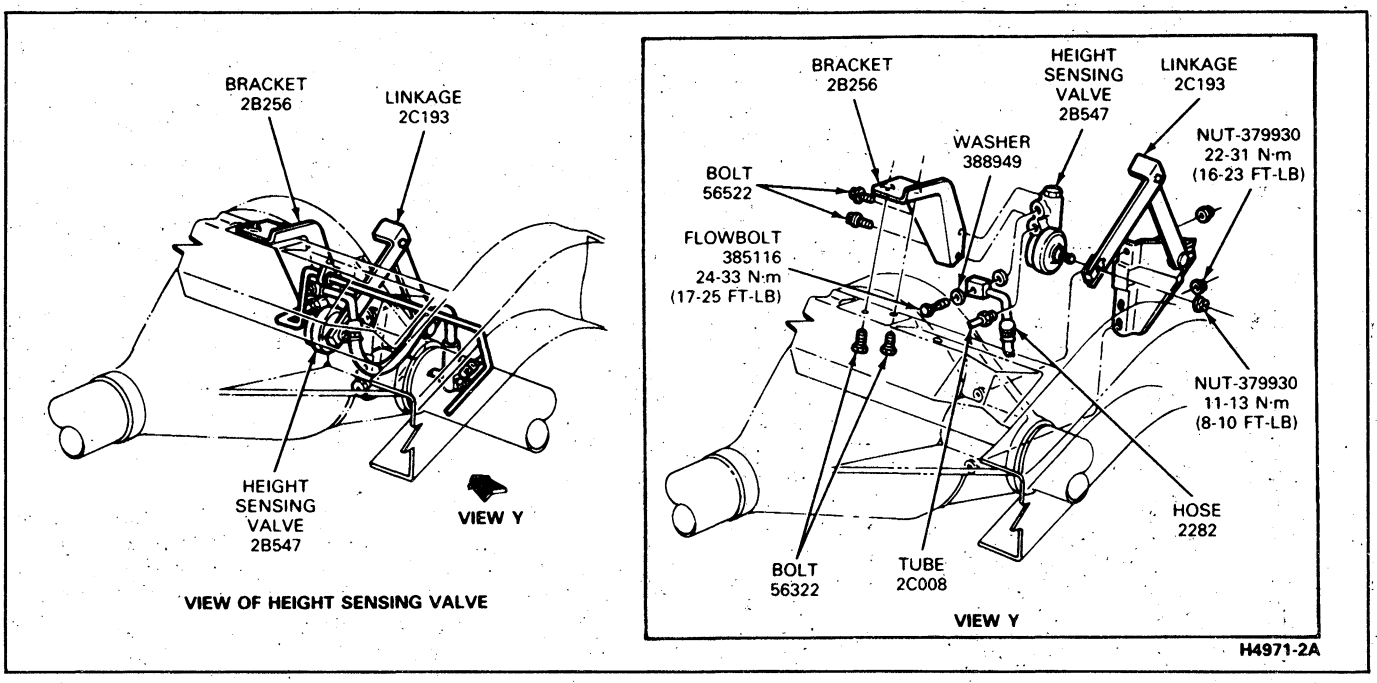


FIG. 5 Height Sensing Brake Proportioning Valve Installation E-250—E-350

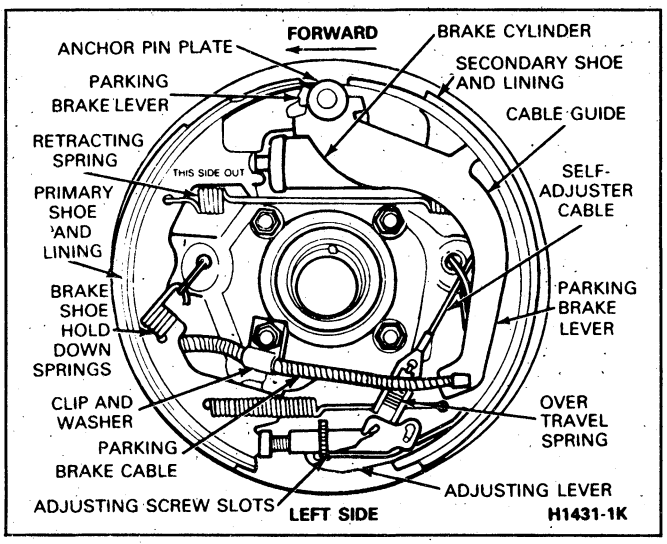


FIG. 6 Self Adjusting Brake Assemblies—F-250—F-350 (4x2) (4x4) and E-250—E-350

2. Turn the ignition switch to the START position. If the brake warning lamp does not light, check the light and wiring and replace or repair wiring, if necessary.

   The brake warning lamp should light only when the ignition key is in the START position or when the ignition key is on and the parking brake is applied, or for diesel engines, when the vacuum is low.

Hydraulic Leak Test

1. With the brakes applied, visually inspect all hydraulic lines, connections, and hoses for evidence of leaks. Replace leaking parts as necessary.
2. If the leak has not been found, on rear drum brakes, remove the brake drums and inspect all wheel cylinders for evidence of leaks. Replace or re-build wheel cylinders as necessary. On disc brakes, inspect for leakage at the caliper. Replace or rebuild the calipers as necessary.
3. If the leak has not been found, disconnect the hydraulic tubes from the master cylinder and plug the output ports using the appropriate size flared tube type plugs. Push the brake pedal down as hard as possible. If the pedal slowly moves downward, the master cylinder is leaking internally and should be re-built or replaced.

Power Brake Function Test

1. With the engine stopped, eliminate all vacuum from the system by pumping the brake pedal several times. Then push the pedal down as far as it will go, and note the effort required to hold it in this position. If the pedal gradually moves downward under pressure, the hydraulic system is leaking and should be subjected to a hydraulic leak test.
2. With the brake pedal pushed all the way down, start the engine. If the vacuum system is operating properly, the pedal will move downward. If pedal position does not change, the vacuum system is not operating properly and should be subjected to a vacuum system test.

Vacuum System Test

Shut the engine off. If the vacuum does not drop more than one inch Hg. in one minute, omit Steps 3 through 8.

1. Disconnect the engine vacuum line from the booster (vehicle with dash mounted booster) and connect a vacuum gauge, Rotunda model 059-00008 or equivalent to the vacuum line with a T-fitting. With the engine thoroughly warmed up, the gauge should read 18-21 inches Hg. at idle with the transmission in neutral. If the idle vacuum is not at least 18-21 inches Hg. the engine requires a tune up.

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2. With the engine properly tuned, connect the vacuum line back up.
3. Inspect the plastic check valve, rubber grommet, and all vacuum plumbing for cracks, holes, bad connections, or missing clamps that might cause leaks. Perform Step 2 of the Power Brake Function Test to determine if the problem has been corrected.
4. Disconnect the vacuum line and connect a vacuum gauge with a T-fitting to the lower part of the dash mounted plastic check valve. Start the engine and let it idle until the gauge reads 17.5-21 inches Hg. Shut the engine off. If the vacuum drops more than one inch in one minute, replace the check valve.
5. If the problem persists, reconnect the test gauge to the same point, leaving the rest of the vacuum system connected this time. Check the vacuum leak down rate as in Step 3. If the system does not pass the test, disconnect the booster and check the vacuum leak down rate holding a thumb over the open end of the line. Only one item should be disconnected at a time. When the system passes the leak down test, the item that is disconnected should be repaired or replaced.
6. If the vehicle is equipped with a dash mounted booster, the plastic check valve should be replaced.
7. With the test gauge connected as in Step 4 or 5, with 17.5-21 inches Hg. of vacuum and the engine shut off, depress the brake pedal one time and release it after holding it down for a few seconds. If the vacuum drops to zero, a booster diaphragm (control or power) is ruptured and the booster should be re-built or replaced.

Master Cylinder

Normal Conditions: The following conditions are considered normal and are not indications that the master cylinder is in need of service:

Condition 1: During normal operation of the master cylinder, the fluid level in the reservoir will rise during brake application and fall during release. The net fluid level, i.e., after brake application and release, will remain unchanged.

Condition 2: A trace of brake fluid existing on the booster shell below the master cylinder mounting flange. This results from the normal lubricating action of the master cylinder bore and seal.

Condition 3: Fluid level will decrease with pad wear.

Abnormal Conditions: Changes in brake pedal feel or travel are indicators that something could be wrong in the brake system. The following conditions use brake pedal feel and the warning lamp along with reservoir fluid level, as indicators in diagnosing brake system complaints.

Condition 1: Pedal goes down fast. This could be caused by an external leak, internal leak or air in the system.

Condition 2: Pedal eases down slowly. This could be caused by an external leak or internal leak.

Condition 3: Pedal is low and/or feels spongy. This condition may be caused by: no fluid in the reservoir, reservoir cap vent holes clogged, rear brakes out of adjustment, or air in the hydraulic system.

Condition 4: Pedal effort excessive. This may be caused by a bind or obstruction in pedal/linkage, or insufficient booster vacuum.

Condition 5: Brake warning lamp on. This may be caused by low fluid level, ignition wire routing too close to fluid level indicator assembly/or float assembly damage.

NOTE: Prior to performing any diagnosis, make certain the brake system warning lamp is functional.

The diagnostic techniques and service procedures are referenced in the Brake Master Cylinder Diagnosis charts. Please refer to these charts for proper use of diagnostic techniques in diagnosing brake hydraulic system problems.

Checking Brake System for External Fluid Leaks

It is possible that all evidence of fluid leakage may have washed off if the vehicle has been operated in rain or snow, as brake fluid is water soluble. Refill system, bleed, and apply the brakes several times. Examine the system to verify that the reservoir fluid level is actually dropping. Locate and correct the external leak. If fluid level drops and no external leak can be found, check for a master cylinder bore end seal leak.

A Master Cylinder Bypass Condition—Checking

1. Check fluid in master cylinder. Fill reservoir if low or empty.
2. Observe fluid level in reservoir. If after several brake applications the fluid level remains the same, measure wheel turning torque required to rotate wheels with brakes applied as follows:
   - Place transmission in Neutral and raise front wheels off the ground.
   - Apply brakes with a minimum of 445 N (100 lbs) and hold for approximately 15 seconds. With brakes still applied, exert torque on front wheels to 101 N·m (75 lb-ft). If either wheel rotates, check internals of master cylinder and replace damaged parts.

CHECKING FOR RESERVOIR SEALING POINTS

An empty reservoir condition may be caused by two types of non-pressure external leaks.

Type 1: An external leak may occur at the master cylinder reservoir cap because of improper positioning of the gasket and cap. Reposition cap and gasket.

Type 2: An external leak may occur at the reservoir mounting grommets. Service such a leak by installing new grommets and reservoir assembly.

Checking for Brake Pedal Reserve

Where a low pedal or the feel of a bottomed out condition exists, check for brake pedal reserve.

1. Operate engine at idle with the transmission in either Park or Neutral position.
2. Depress brake pedal lightly three to four times.
3. Allow 15 seconds for vacuum to replenish booster.
4. Apply brake pedal until it stops moving downward or an increased resistance to the pedal travel occurs.

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NOTE: This increased resistance may feel like something has bottomed out.

5. Hold pedal in applied position and raise the engine speed to approximately 2,000 rpm.
6. Release accelerator pedal and observe that brake pedal moves downward as engine returns to idle speed.

NOTE: The additional movement of the brake pedal is the result of the increased engine manifold vacuum which exerts more force on the brake booster during engine rundown. This means that additional stroke is available in the master cylinder, and the brake system is not bottoming out as a customer may believe.

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in diagnosing hydraulic brake systems.

ADJUSTMENTS

Brake Pedal Adjustment

On dual-brake master cylinder or dash mounted vacuum booster equipped vehicles, the brake systems are designed to permit a full stroke of the master cylinder when the brake pedal is fully depressed. A brake pedal clearance adjustment is not required.

CONDITION	POSSIBLE CAUSE	RESOLUTION
• Brake warning light on.	1. Low fluid level.	1. Add fluid, bleed system and check for leaks.
	2. Low vacuum level (diesel only).	2. Refer to Section 12-56, Brake Booster Vacuum Pump — 7.3L Diesel Engine for diagnosis and testing procedures.
	3. Shorted light circuit.	3. Correct short in warning circuit.
	4. Worn or damaged brake warning switch.	4. Replace switch.
	5. Leak in brake system.	5. Repair leak.
• Brakes not working, excessive pedal travel, brake pedal feels spongy when fully applied.	1. Rear brakes out of adjustment.	1. Adjust rear brakes.
	2. Front wheel bearing out of adjustment.	2. Adjust front wheel bearings.
	3. Master cylinder or booster dash unit mounting loose.	3. Tighten nuts and bolts to specification.
	4. Disc brake caliper attachment loose.	4. Replace or tighten as required.
	5. Worn or damaged self-adjusters.	5. Remove drum and check lining for proper adjustment. Replace self-adjusters.
	6. Glazed, worn, scored or damaged brake linings.	6. Replace brake shoes and linings in sets.
	7. Drum out of round or rotors with excessive runout.	7. Refinish, or replace if wear exceeds limits.
	8. Brake tubing improperly positioned.	8. Check brake tubing for misposition near heat source. Hot fluid can boil and result in spongy pedal response.
• Excessive pedal travel or pedal goes to floor consistently.	1. Hydraulic system.	1. Perform master cylinder diagnosis test. Refer to master cylinder diagnosis chart. Repair as required.
	2. Drum brakes out of adjustment, worn, bad wear pattern, or cracked drums.	2. Repair or replace as required.
	3. Loose or improper attachment of pedal, pedal support booster and master cylinder.	3. Repair or replace as required.
	4. Misaligned anchor plate.	4. Refer to misaligned disc brake anchor plate diagnosis. Repair as required.

CH3908-2D

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Excessive pedal effort to fully apply brakes.	1. Overloaded vehicle.	1. Lighten load and advise owner of correct load limits of vehicle.
	2. Insufficient vacuum to brake booster.	2. Replace damaged or leaking vacuum hoses.
	3. Restricted air filter on power brake booster.	3. Clean or replace filter.
	4. Booster and brake pedal linkage binding caused by worn bushings or corrosion.	4. Replace worn bushings or clean and lubricate linkage.
	5. Worn or damaged brake booster.	5. Replace booster.
	6. Brake lining worn, glazed, contaminated or improper type.	6. Replace brake lining in axle sets.
	7. Brake shoe and lining improperly installed.	7. Reposition brake shoes properly and eliminate any binding.
	8. Seized pistons in wheel cylinders or seized calipers.	8. Repair or replace as required.
	9. Restricted brake lines or hoses.	9. Repair or replace as required.
	10. Inoperative height sensing valve. (E-250—E-350 only.)	10. Check vehicle ride height and control linkage.
• Intermittent loss of pedal.	1. Hydraulic system.	1. Perform master cylinder diagnosis. Repair as required.
	2. Front wheel bearings out of adjustment.	2. Adjust front wheel bearings.
	3. Drum brakes out of adjustment, worn, bad wear pattern or cracked drums.	3. Repair or replace as required.
	4. Loose or improper attachment of pedal, pedal support, booster and master cylinder.	4. Repair or replace as required.
	5. Misaligned anchor plate.	5. Refer to misaligned disc brake anchor plate diagnosis. Repair as required.
• Brakes pull to one side.	1. Unequal air pressure in tires.	1. Inflate tires to correct pressure.
	2. Grease or fluid on linings. Contaminated linings.	2. Clean, sand and/or replace linings.
	3. Improper size or type of lining on one wheel.	3. Replace with correct brake linings in sets.
	4. Improper size wheel cylinder on one wheel.	4. Replace with correct wheel cylinder.
	5. Stuck or seized pistons in wheel cylinders of seized calipers.	5. Repair or replace as required.
	6. Restricted brake lines or hoses.	6. Repair or replace as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Brakes pull to one side. (Continued)	8. Other brake components. — Improper adjustment of drum brakes. — Improper positioning of disc brake shoe and lining in the caliper. — Improperly adjusted, damaged or worn wheel bearings. — Distorted drum brake shoes. — Worn brake linings. — Missing, broken or stretched retracting or retaining springs and clips. 9. Should brake system check OK and complaint still exists, see suspension, steering and tire section of this manual for front end, toe-alignment, etc.	8. Inspect, adjust, repair or replace as required.
• Brakes grab or lock up when applied.	1. Tires worn or incorrect pressure. 2. Grease or fluid on linings — damaged linings. 3. Improper size or type of linings. 4. Over-reaction of brake booster. 5. Rear brakes continually lock up at low pedal effort. 6. Other brake system components. — Worn, damaged or dry wheel bearings. 7. Parking brake cable binding or out of adjustment. 8. Parking brake cable control assembly binding.	1. Inflate tires to correct pressure. Replace tires with worn tread. 2. Inspect, repair, or replace linings in sets. 3. Replace with correct brake linings in sets. 4. Check brake booster for over-reaction by comparing with a known quality vehicle. Replace brake booster if required. 5. Replace rear Antilock Brake (RAB) Valve on F-150—F-350 and Bronco or Height Sensing Valve on E-150—E-350. 6. Inspect, repair, or replace as required. 7. Adjust cables. Repair, lubricate, or replace if required. 8. Repair, lubricate or replace if required.
• Brakes drag, slow or incomplete release.	1. Parking brake control or cables binding. 2. Brake pedal binding. 3. Front wheel bearing out of adjustment.	1. Repair, lubricate, or replace parts as required. 2. Repair, lubricate, or replace parts as required. 3. Check bearings for adjustment, wear, damage. Adjust bearings.

CH3910-2C

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Brakes drag, slow or incomplete release. (Continued)	4. Worn or damaged master cylinder.	4. Check master cylinder for open compensator ports. Repair or replace.
	5. Brakes out of adjustment.	5. Adjust brakes.
	6. Restriction in hydraulic system.	6. Repair or replace as required.
	7. Seized wheel cyinders or caliper pistons.	7. Repair or replace as required.
	8. Stoplight switch out of adjustment.	8. Adjust switch.
	9. Lack of lubricant on disc brake caliper slides.	9. Lubricate disc brake caliper slides.
	10. Speed control dump valve inoperative.	10. Repair or replace as required.
• Noise at wheels when brakes are applied — snap or clicks.	1. Cracked welds as brake shoe web.	1. Replace brake shoe and lining assemblies in axle sets.
	2. Brake shoes binding at backing plate ledges.	2. Clean and lubricate ledges.
	3. Machining marks on brake drums.	3. Refinish, or replace brake drums.
	4. Backing plate ledges worn.	4. Replace backing plate and lubricate ledges.
	5. On disc brakes — loose or missing anti-rattle clips.	5. Replace.
	6. Other brake system components. — Loose outer shoe crimping.	6. Inspect, repair or replace.

CH3914-2C

To release the brakes, fluid must flow back to the master cylinder through a return port when pedal pressure is released. To be sure the piston moves back far enough to expose the return port, free-travel is built into the pedal linkage on standard and frame-mounted booster systems. This prevents the piston from becoming trapped in a partially released position. Pedal free travel is not always perceptible in dash-mounted booster systems, because the operating clearance for the piston is adjusted at the booster push-rod, rather than the pedal linkage. (Refer to Sections 12-50 Vacuum Brake Booster—Single Diaphragm—Dash Mounted (Bendix) and 12-52 Vacuum Brake Booster—Tandem Diaphragm—Dash Mounted (Bendix) for instructions on a dash-mounted booster push rod adjustment).

Dump Valve Adjustment

(Vehicles with Speed Control Only)

NOTE: Installation and adjustment of the Dump Valve must be done prior to draining and filling of the master cylinder.

The brake pedal must be pulled back toward the driver's seat to the full extension of the master cylinder pushrod. Do not apply more than 15 lbs. of force to the brake pedal to establish the maximum rearward position.

Front Disc Brakes

F-150-F-350 (4x2), F-150-F-350 (4x4), Bronco, E-150-E-350 and F-Super Duty Series Vehicles

The front disc brake assembly is designed so that it is self-adjusting. Refer to Section 12-24 Disc Brake-Light and Heavy Duty—Sliding Caliper.

Rear Disc Brakes

F-Super Duty Series Vehicles

The rear disc brake assembly is designed so that it is self-adjusting. Refer to Section 12-24 Disc Brake—Light and Heavy Duty—Sliding Caliper.

Rear Drum Brakes

F-150—F-350 (4x2), F-150—F-350 (4x4), Bronco and E-150—E-350

Rear drum brakes are adjusted automatically by alternately driving the vehicle forward and reverse, and sharply applying the brakes when the vehicle is driven in reverse. Manual brake adjustment is required only when the brake shoes are relined or replaced. Refer to Section 12-02, Drum Brakes—Single Cylinder, Dual Piston.

Hydraulic System Bleeding

When any part of the hydraulic system has been disconnected for repair or replacement, air may get into

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Noise at wheels — brakes applied — squeak or squeal. A loud, sharp, high-pitched moderately prolonged sound that occurs while braking. Occasional or intermittent brake squeal/squeak may result from environmental conditions such as cold, heat, wetness, snow, salt, mud, etc. This condition is not a functional one and will not affect brake effectiveness.	1. Brake lining and/or rotor surface contamination.	1. Remove caliper assembly from spindle and remove inner and outer linings. Hand sand the linings and both braking surfaces of rotor. Use Garnett Paper 100A (medium grit) or equivalent or aluminum oxide 150J (medium) or equivalent. Turning or replacing rotors is not an effective repair for squeal.
	2. Disc Brakes — Missing or damaged brake pad insulators.	2. Replace insulators or replace shoe and lining assembly if pads are worn.
	3. Improper lining parts.	3. Inspect for correct usage. Replace as required.
	4. Drum Brakes — Loose lining rivets, weak, damaged or incorrect shoe retracting springs, loose or damaged shoe retainer pins, springs and clips, and grooved backing plate ledges.	4. Inspect, repair or replace as required.
Noise at wheels — brakes not applied — squeak or squeal.	1. Wheel covers improperly attached.	1. With a rubber mallet, seat the wheel covers. Repair flanges or repair cover.
	2. Loose wheel lug nuts.	2. Tighten to specified torque. Replace wheel if stud holes are elongated.
	3. Worn, dry or improperly adjusted wheel bearings.	3. Replace worn or damaged wheel bearings. Lubricate and adjust.
	4. Bent or warped backing plate causing interference with drum or rotor.	4. Repair or replace as required.
	5. Contaminated linings — adjustment too tight (Rear brakes).	5. Remove contamination from linings. Adjust brakes properly.
	6. Improper machining of drum, causing interference with backing plate or shoe.	6. Replace shoe.
	7. Other brake system components: — Loose or extra parts in brakes. — Drum Brakes — Weak, damaged or incorrect retracting springs. — Drum Brakes — Grooved backing plate ledges. — Improper positioning of shoe in caliper. — Outside diameter of rotor rubbing caliper housing. — Lack of correct lubricant on disc brake caliper slides and pins. — Improper installation of disc brake anti-rattle clips. — Excessive runout of disc brake rotor.	7. Inspect, repair or replace as required.

CH3911-2B

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Noise at wheels when brakes are applied — scrape or grind (loud, harsh rubbing noise).	1. Contaminated linings — If caliper is not bound, brake linings are not worn to rivets, and rotor is scored at least 13mm (0.5 inch) wide by 1.5mm (1/16 inch) deep.	1. Replace or turn rotor. Remove and replace contaminated lining as required.
	2. Wheel bearings not lubricated. Verify noise is coming from bearings.	2. Lubricate and replace bearings and seals as required.
	3. Worn brake linings, loose rivets or foreign material between lining and drum or rotor.	3. Replace shoes and linings in sets. Refinish brake drums or rotors if excessively scored.
	4. Brake shoe interference with back of drum, or shield-to-rotor clearance also binding at backing plate guide ledges.	4. Inspect. Replace as required. Lubricate guide ledges.
	5. Caliper to wheel or rotor interference.	5. Replace as required.
	6. Other brake system components: — Warped or bent backing plate or splash shield causing interference with brake drum. — Cracked drums or rotors.	6. Inspect and repair as required.
	7. Tires rubbing against chassis or body.	7. Inspect and service as required.
	8. Rotor to spindle interference.	8. Replace as required.
Noise at wheels — brakes applied — groan, roughness or chatter at wheel. A harsh feeling while braking in neutral evidenced by a pulsating brake pedal feel.	1. Loose wheel lug nuts.	1. Tighten to specified torque. Replace wheel if stud holes are elongated.
	2. Corrosion build-up on rotor surfaces.	2. Hand sand corrosion from rotor braking surfaces and contamination from linings.
	3. Worn, damaged, dry or improperly adjusted wheel bearings.	3. Inspect, lubricate and/or replace as required.
	4. Loose or worn front suspension components.	4. Inspect, repair or replace as required.
	5. Rotor thickness variation.	5. Replace or turn rotor.
	6. Disc brake caliper backing plate and anchor plate loose or missing parts. Also, loose or bent dust shield.	6. Replace or repair as required.
	7. Rear brake roughness.	7. Attempt stopping the vehicle using the parking brake. If roughness is present, check drums for excessive wear or runout. Refinish or replace as required.

CH3912-2B

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Noise at wheels — brakes applied — groan; roughness or chatter at wheel. A harsh feeling while braking in neutral evidenced by a pulsating brake pedal feel. (Continued)	8. Brake drum cracked or out-of-round. 9. Wheel/tire imbalance. 10. Drivetrain imbalance.	8. Refinish or replace drum as required. 9. Verify and repair as required. 10. Attempt stopping the vehicle in the neutral transmission position. If roughness is gone, drivetrain should be inspected.
Noise at wheels — brakes not applied — growling, click, rattle, clunk or knock. Defined by a series of sharp, short sounds in quick succession.	1. Stones or foreign material trapped inside. 2. Loose wheel lug nuts. 3. Worn, damaged or dry wheel bearings. 4. Disc brake caliper assembly. — Loose or missing anti-rattle clips or poor crimping on outer shoe. 5. Drum brakes loose or extra parts. 6. Dust shield bent, loose or missing. 7. Loose grease cap. 8. Drum brakes — brake shoes binding at backing plate ledges in three places. 9. Drum brakes — backing plate ledges worn in three places.	1. Remove stones or foreign material as required. 2. Tighten to specified torque. Replace wheel if stud holes are elongated. 3. Inspect, lubricate or replace. Adjust bearings properly. 4. Inspect, repair or replace as required. 5. Inspect, remove or repair as required. 6. Repair as required. 7. Repair or replace as required. 8. Lubricate ledges. 9. Replace plate and lubricate ledges.

CH3915-2C

the lines and cause spongy pedal action. This requires the bleeding of the hydraulic system after it has been properly connected to be sure all air is expelled from the brake cylinders and lines. The hydraulic system can be bled with pressure bleeding equipment such as Rotunda Brake Bleeder model 104-00064 or equivalent.

Bleed one brake cylinder at a time. On F-150—F-350 and Bronco vehicles, start the bleeding at the right rear brake wheel cylinder and then to the left rear wheel brake cylinder. After completing; proceed to the Rear Antilock Brake RABS Valve. Then proceed to bleed the front brakes, starting with the right front brake and finish bleeding on the left front brake. On E-150—E-350 vehicles, start the bleeding at the right rear brake, then the left rear brake. After completing, proceed to bleed the right front brake and then the left front brake. Keep the master cylinder reservoir filled with the specified Ford Heavy Duty Brake Fluid, C6AZ-19542-AA or BA (ESA-M6C25-A) or equivalent. **Never use brake fluid that has been drained from the system.**

Pressure Bleeding—Dual Brake System Hydraulic Master Cylinder

Bleed the longest lines first. Be sure the bleeder tank contains enough specified brake fluid (Ford Heavy Duty Brake Fluid C6AZ-19542-AA or BB (ESA-M6C25-A) or equivalent) to complete the bleeding operation. Charge the tank with approximately 69-206 kPa (10-30 psi) of air pressure. **Never exceed 345 kPa (50 psi) of pressure. Never re-use brake fluid that has been drained from the hydraulic system.**

1. Clean all dirt from the master cylinder cap.
2. Remove the master cylinder reservoir cap, and fill the master cylinder reservoir with the specified brake fluid. Install the pressure bleeder adapter tool to the master cylinder, and attach the bleeder tank hose to the fitting on the adaptor.

   Master cylinder pressure bleeder adapter tools are available from various manufacturers of pressure bleeding equipment. Follow the instructions of the manufacturer when installing the adaptor.
3. Place a 3/8-inch box wrench on the bleeder fitting on the right rear brake wheel cylinder. Attach a bleeder tube snugly around the bleeder fitting.
4. Open the valve on the bleeder tank to admit pressurized brake fluid to the master cylinder reservoir.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Vibration when brakes are applied — Front Brakes.	1. Loose lug nuts.	1. Tighten lug nuts to specification. Replace rim if stud holes are elongated.
	2. Cracked rotors.	2. Replace rotor.
	3. Rotors out-of-round or improper machining.	3. Machine rotors or replace as required.
	4. Excessive rotor runout.	4. Replace rotor.
	5. Worn or improperly adjusted wheel bearings.	5. Adjust or replace wheel bearings as required.
	6. Loose or worn front suspension components.	6. Tighten loose components to specifications. Replace worn or damaged components.
	7. Excessive radial or lateral run-out on wheel and tire.	7. Adjust tire and wheel to eliminate excessive run-out or tire and/or wheel as required.
• Vibration when brakes are applied — Rear Brakes.	1. Loose lug nuts.	1. Tighten lug nuts to specification. Replace rim if stud holes are elongated.
	2. Cracked drums.	2. Replace drums.
	3. Drums out-of-round or improperly machined.②	3. Machine drums or replace as required.
	4. Excessive radial and lateral run-out on wheel and tire.①	4. Adjust tires and wheels to eliminate run-out or replace wheel and/or tire as required.
• Parking brake will not hold.	1. Parking brake cable out of adjustment.	1. Adjust parking brake cable(s).
	2. Rear brakes out of adjustment.	2. Adjust rear brakes.
	3. Parking brake linkage, cable release lever, clevis and ratchet binding, worn or damaged.	3. Repair or replace linkage or cables as required.
• Parking brake will not release or fully return.	1. Manual release brake control components binding or damaged.	1. Repair or replace manual parking brake control.
	2. Parking brake linkage and cables binding.	2. Repair or replace as required.
	3. Worn or damaged rear brake components.	3. Check rear brake shoe retracting springs and parking brake levers. Repair as required.
• Rough engine idle or stall — power brake only.	1. Vacuum leak.	1. Check vacuum hoses and connections for leaks. Repair or replace as required.
	2. Worn or damaged vacuum booster.	2. Check vacuum booster for internal leaks. Replace if required.
• Misaligned disc brake anchor plate.	1. Worn or damaged anchor plate.	1. Measure distance between outer disc brake shoe (not lining) and rotor at both upper and lower corners. The shoe must be seated flat against the caliper legs when checks are made. Replace the disc brake anchor plate on the affected side and shoe and lining assemblies on both front brakes.

① TIRE AND WHEEL RUNOUT SPECIFICATIONS:
Radial Runout — Tire — 1.77mm (0.070 Inch)
— Wheel — 1.14mm (0.045 Inch)
Lateral Runout — Tire — 1.77mm (0.070 Inch)
— Wheel — 1.14mm (0.045 Inch)

② DRUM RUNOUT SPECIFICATIONS MEASURED
19.05mm (3/4 Inch)
11-Inch Brakes — 0.177mm (0.007 Inch) TIR Maximum
12-Inch Brakes — 0.177mm (0.007 Inch) TIR Maximum

CH3913-2C

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MASTER CYLINDER DIAGNOSIS

TEST STEP		RESULT	ACTION TO TAKE
1.0	FLUID LEVEL CHECK		
	• Check fluid level in master cylinder reservoir.	Full reservoir (OK) ▶	GO to **2.0**.
		Low or empty reservoir with no brakelight (OK) ▶	REPLACE reservoir.
2.0	FLUID LEVEL CONDITION		
	• Apply and release brake pedal one full stroke. Observe reservoir fluid level of both chambers as pedal is released.	Level remains constant (OK) ▶	GO to **3.0**.
		Fluid level drops (OK) ▶	External leak in brake system cylinder. REPAIR leak.
3.0	MASTER CYLINDER CONDITION		
	• Wipe off exterior of master cylinder, cover and gasket with clean cloth. • Road test vehicle and pump brakes. • Check if master cylinder exterior is dry or wet. Check for fluid from bore end of booster or dash.	Dry master cylinder exterior ▶	GO to **4.0**.
		Wet master cylinder exterior or dripping fluid from booster or dash ▶	External leak in master cylinder. REPAIR master cylinder.
4.0	MASTER CYLINDER CONDITION		
	• Hold pressure on pedal unit pedal goes down.	Pedal goes down 3.175mm (1/8 inch) each time pedal is released ▶	CHECK entire brake system for major leak. REPAIR as required.
		▶	REFER to BRAKES NOT WORKING, EXCESSIVE PEDAL TRAVEL, BRAKE PEDAL FEELS SPONGY WHEN FULLY APPLIED in diagnosis guide.

CH3578-2C

5. Submerge the free end of the tube in a partially filled container with clean brake fluid and loosen the bleeder fitting.
6. When air bubbles no longer appear in the fluid at the submerged end of the bleeder tube, close the bleeder fitting and remove the tube.
7. When the bleeding operation is completed, close the bleeder tank valve and remove the tank hose from the adaptor fitting.
8. **Remove the Pressure Bleeder Adapter Tool. Fill the master cylinder reservoir to the minimum level line. Install the master cylinder cap.**

Hydraulic Line Repair

Steel tubing is used in the hydraulic lines between the master cylinder and the front brake tube connector and between the rear brake tube connector (Fig. 7) and the rear brake cylinders. Flexible hoses connect the brake tube to the front brake cylinders and to the rear brake tube connector.

When replacing hydraulic brake tubing, hoses, or connectors, tighten all connections securely. After replacement, bleed the brake system at the wheel cylinders and at the booster, if equipped.

Brake Tube

If a section of the brake tube is damaged, replace the entire section with tubing of the same type, size, shape, and length. **Copper tubing should not be used in the hydraulic system. Use only SAE J526 or J527 steel tubing, or equivalent.** Be careful not to kink or crack the tubing when bending it to fit the frame or rear-axle forms.

Double flare brake tubing as described below should provide good leak-proof connections. Always clean the inside of a new brake tube with clean isopropyl alcohol.

Flaring A Line (Split-Die Type)

Refer to Figs. 8 and 9.

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MASTER CYLINDER DIAGNOSIS GUIDE
PEDAL GOES DOWN FAST

TEST STEP		RESULT	ACTION TO TAKE
A0	VERIFY CONDITION		
• Road test vehicle and depress brake pedal.		(OK) ▶	Vehicle OK.
		(OK) ▶	GO to **A1**.
A1	BRAKE FLUID LEVEL		
• Check master cylinder brake fluid reservoir level.		(OK) ▶	GO to **A2**.
		(OK) ▶	CHECK reservoir sealing points. ADD fluid and BLEED system. REPEAT test **A0**.
A2	PRESSURIZE SYSTEM		
• Pump brake pedal rapidly (five times).		Pedal height builds up, then sinks. ▶	GO to **A3**.
		Pedal height builds up and holds. ▶	CHECK rear brake adjustment and ADJUST if necessary. If condition still exists, BLEED system for air. REPEAT test **A0**.
A3	BRAKE SYSTEM LEAKS		
• Check for external brake system leaks. As detailed in this section.		(OK) ▶	GO to **A4**.
		(OK) ▶	SERVICE as necessary. ADD fluid and BLEED system. REPEAT test **A0**.
A4	MASTER CYLINDER BY-PASS TEST		
• Test for master cylinder by-pass. As detailed in this section.		(OK) ▶	System OK.
		(OK) ▶	REPLACE damaged parts. ADD fluid and BLEED system. REPEAT test **A0**.

CH4944-2D

1. Cut off and straighten the required length of line (A tubing cutter tool will simplify making a clean and square cut).
2. Square off the ends of the line with a file, and chamfer the end of the line to be flared.
3. Select the split die for the line to be used and insert the die into the tapered hole in the body.
4. Push the tube through the die until the line is even with the face of the die. Lock the line in this position by tightening the wing nut securely.
5. The punches are marked Op. 1 and Op. 2. Slide the first operation punch into the hole in the center of the body and tighten the screw securely to form the single flare.
6. Release the screw and replace the first operation punch with the second punch and tighten the screw to form the double flare.
7. Release the screw, wing nut, punch, and dies.
8. Remove the line and inspect the flare for cracks or poor flare form. If the flare is not correct, cut it off and repeat the process.

The finished flare must be square with the line, free of cracks and have a smooth mating surface to ensure a leakproof connection.

Flaring A Line (Flaring-Bar Type)

Refer to Fig. 10.

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MASTER CYLINDER DIAGNOSIS GUIDE (Cont'd.)
PEDAL EASES DOWN SLOWLY

TEST STEP		RESULT ▶	ACTION TO TAKE
B0	VERIFY CONDITION		
• Check if condition occurs during actual stopping application by depressing the brake pedal while the vehicle is moving.		Condition occurs only when vehicle is stationary. ▶	No action required. (SEE Normal Condition #1.)
		Condition occurs while vehicle is moving and braking performance is affected. ▶	GO to **B1**.
B1	BRAKE SYSTEM LEAKS		
• Check for external brake system leaks. As detailed in this section.		(OK) ▶	GO to **B2**.
		(~~OK~~) ▶	SERVICE as necessary, ADD fluid and BLEED system. REPEAT Test **B0**.
B2	MASTER CYLINDER BY-PASS TEST		
• Test for master cylinder by-pass. As detailed in this section.		(OK) ▶	System OK.
		(~~OK~~) ▶	REPLACE damaged parts, ADD fluid and BLEED SYSTEM. REPEAT Test **B0**.

CH4945-2D

MASTER CYLINDER DIAGNOSIS GUIDE (Cont'd.)
PEDAL EFFORT EXCESSIVE

TEST STEP		RESULT ▶	ACTION TO TAKE
D0	VERIFY CONDITION		
• Depress brake pedal fully several times.		Pedal has short stroke and requires excessive effort. ▶	GO to **D1**.
		Pedal has long stroke and requires excessive effort. ▶	GO to **D1**.
D1	BRAKE PEDAL LINKAGE TEST		
• Detach booster push rod from pedal pin and depress brake pedal fully.		Pedal moves freely. ▶	CHECK booster vacuum availability as described under Vacuum Booster Diagnosis in this Section.
		Condition persists. ▶	SERVICE or REPLACE brake pedal linkage. REPEAT Test **D0**.

CH4946-2C

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MASTER CYLINDER DIAGNOSIS GUIDE (Cont'd.)
PEDAL IS LOW AND/OR FEELS SPONGY

TEST STEP	RESULT ▶	ACTION TO TAKE
C0 VERIFY CONDITION		
• Road test vehicle and apply brake pedal.	(OK) ▶	Vehicle OK.
	(OK) ▶	GO to **C1**.
C1 BRAKE FLUID LEVEL CHECK		
• Check master cylinder brake fluid reservoir level.	(OK) ▶	GO to **C2**.
	(OK) ▶	CHECK reservoir sealing points. ADD fluid and BLEED system.
C2 FILLER CAP VENT CHECK		
• Check if filler cap vent holes are clogged or dirty.	(OK) ▶	GO to **C3**.
	(OK) ▶	CLEAN as necessary. REPEAT Test **C0**.
C3 BLEED BRAKE SYSTEM		
• Bleed brake system as described in this section.	Condition corrected ▶	Vehicle OK.
	Condition persists ▶	GO to **C4**.
C4 FRONT WHEEL BEARING ADJUSTMENT		
• Check front wheel for proper adjustment.	(OK) ▶	CHECK rear brake adjustment and ADJUST if necessary. REPEAT Test **C0**.
	(OK) ▶	Adjust front wheel bearings. REPEAT Test **C0**.

CH4947-2D

1. Cut off and straighten the required length of line. (A tubing cutter tool will simplify making a clean and square cut).
2. Square off the ends of the line with a file, and chamfer the end of the line to be flared.
3. Insert the line through its appropriate ribbed hole in the bar assembly until the end of the line sticks out about as far as the thickness of the adapter above the bar, or even with the bar, depending on the tool used.
4. Fit the adapter onto the line and slide the bar into the yoke. Lock the bar in position with the line beneath the yoke screw.
5. Form the single flare by tightening the yoke screw securely.
6. Release the screw and remove the adaptor.
7. Form the double flare by tighening the yoke screw again, with second adaptor fitted, depending on the tool used.
8. Release the screw bar, and flared line. Inspect the flare for cracks or poor flare form, and repeat the process if the flare is not correct.

Brake Hose

Replace a flexible brake hose if it shows signs of softening, cracking or other damage.

When installing a new brake hose, position the hose to avoid contact with other vehicle parts.

OVERHAUL

Removal of dust and dirt from brake assemblies should be done by using the Rotunda Bake Vacuum model 091-00001 or Rotunda Brake Parts Washer model 065-00016 or an equivalent. Brake assembly dust and dirt should **not** be removed by either blowing off with an air gun or vacuuming with a standard industrial vacuum cleaner because a health hazard from breathing in asbestos dust may develop. Also, any machining done on brake linings or pads should be done using properly exhaust ventilated equipment.

Brake Drum Refinishing

Minor scores on a brake drum can be removed with fine emery cloth, provided the emery is thoroughly cleaned off the drum after the operation.

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FRONT DISC BRAKE VIBRATION — SHUDDER — E-250-350 AND F-250-350 WITH DANA AXLE

TEST STEP		RESULT	ACTION TO TAKE
1	ROAD TEST		
	• With standard wheels and tires installed, road test the vehicle and verify the condition.	Front brake chirp ▶	Normal condition. No repair required.
		No shudder/vibration ▶	Brake system not responsible. REFER to Section 18-01, Noise, Vibration and Harshness.
		Shudder/vibration ▶	GO to **2.**
2	APPLY PARKING BRAKE		
	• Lightly apply the parking brake and road test the vehicle.	No shudder/vibration ▶	CHECK the front brakes. GO to **3.**
		Shudder/vibration ▶	CHECK the rear brakes. GO to **4.**
3	DISC BRAKES		
	• Resurface rotors and road test vehicle.	No shudder/vibration (OK) ▶	STOP.
		Shudder/vibration (OK) ▶	REPLACE rotors.
4	DRUM BRAKES		
	• Refinish brake drums and road test vehicle.	No shudder/vibration (OK) ▶	STOP.
		Shudder/vibration (OK) ▶	REPLACE drums.

CH3633-2B

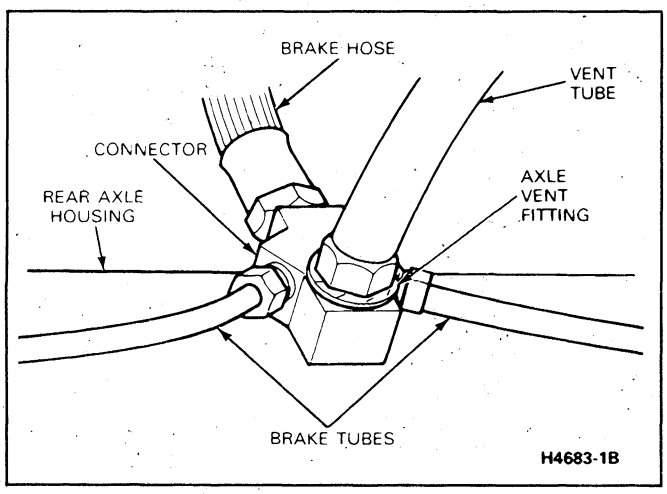


FIG. 7 Rear Brake Tube Connector

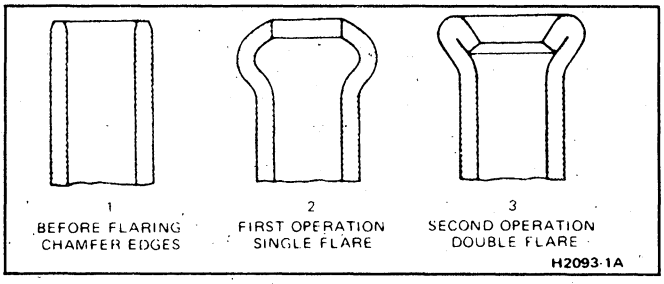


FIG. 8 Line Flaring Sequence

A badly scored, rough, or out-of-round drum should be ground or turned on a drum lathe. (Refer to the lathe manufacturers instructions.) Do not remove any more material from the drum than is necessary to provide a smooth surface for the brake shoe contact. Brake drum maximum braking surface diameter is shown on each brake drum (Fig. 11). Brake drums which exceed the maximum braking surface diameter shown on the brake drum, either through wear or refinishing, must be replaced. The maximum braking surface diameter specification, which is shown on each brake drum (Fig. 11), allows for a 1.52mm (0.060 inch) machining cut over the original drum diameter plus 0.762mm (0.030 inch) additional wear before reaching the drum-discard diameter. Braking Surface Diameter Marking Location—E-150—E-350, Bronco, and F-150—F-350

Front Disc Brakes

1. Remove the shoe and linings as described in Section 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper.

2. Measure the thickness of the brake lining. If the lining thickness at any point on the assembly is less than 1.5mm (1/16 inch) above the backing plate or 0.794mm (1/32 inch) above the rivets, or if the lining shows evidence of brake fluid or oil

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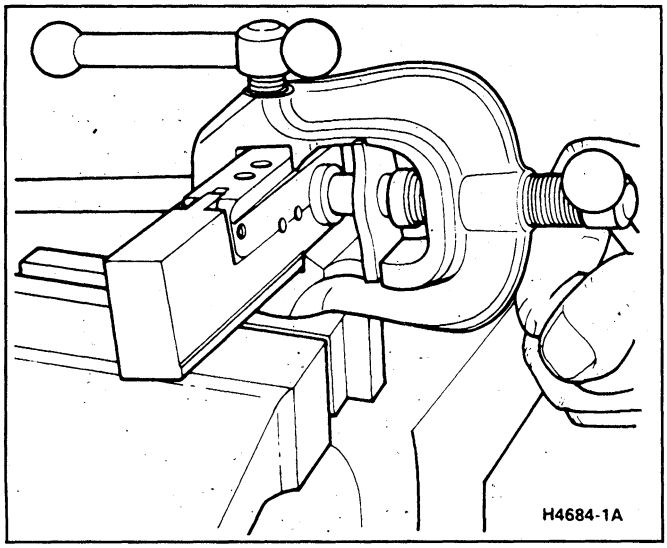


FIG. 9 Line Flaring (Split Die Type)

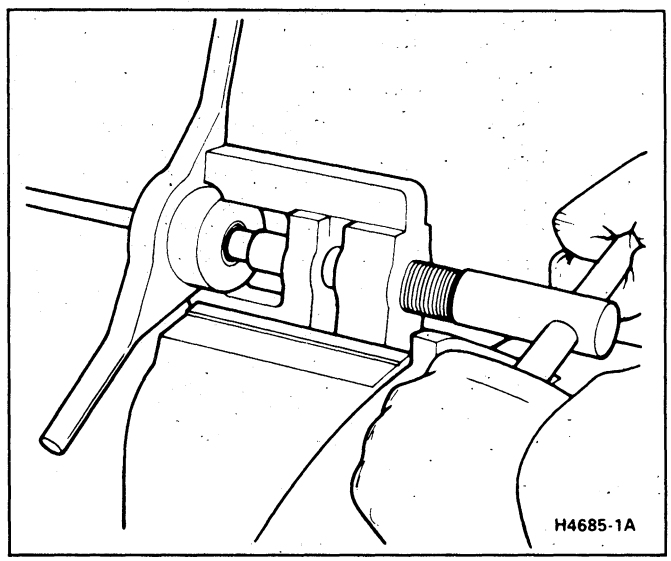


FIG. 10 Line Flaring (Flaring Bar Type)

contamination that is causing a brake pull, replace all four shoe and lining assemblies.

3. To check rotor runout, first eliminate the wheel bearing end play by tightening the adjusting nut. Then check to be sure the rotor can still be rotated.
4. Clamp a dial indicator TOOL-4201-C, or equivalent to the spindle so the stylus contacts the rotor approximately one inch from the outer edge. Rotate the rotor and take an indicator reading. If the reading exceeds allowable total lateral runout (as given in Section 12-24) within a six inch radius on the indicator, replace or re-surface the disc brake rotor. **The following requirements must be met when re-surfacing disc brake rotors.**

   Use a disc brake lathe to re-finish the disc brake rotors. (Follow the manufacturers instructions.)

   Replace the rotor when the overall thickness is at or below the specified minimum thickness shown on the rotor. Refer to the specifications at the end of Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper for minimum (discard) rotor thickness, maximum rotor brake surface lateral runout, thickness variation, and surface finish.

   When the runout check is finished, adjust the bearings as described in Section 11-10, Wheel Hubs and Bearings—Front (except Front Wheel Drive) to prevent bearing failure.
5. Check the rotor for scoring. Remove minor scores with a fine emery cloth. If the rotor is excessively scored, re-finish or replace the rotor if necessary.
6. Check the caliper. If it is cracked or shows any signs of leakage, replace it. If the caliper is leaking around the dust boot, remove and repair it.
7. Check brake hoses for signs of cracking, leaks or abrasion. Replace them, if necessary.

Rear Disc Brakes

1. Remove the shoe and linings as described in Section 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper.
2. Measure the thickness of the brake lining. If the lining thickness at any point on the assembly is

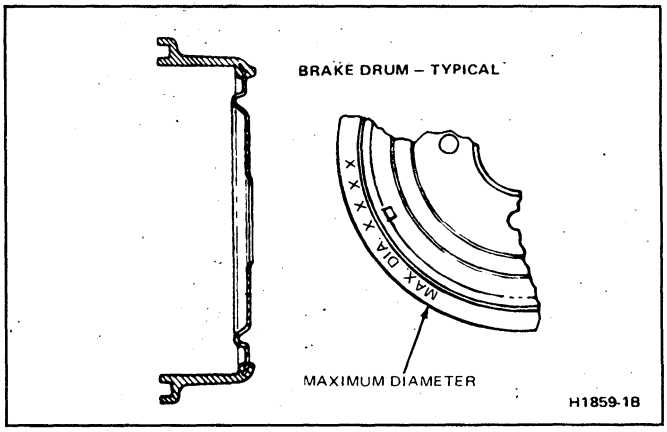


FIG. 11 Rear Brake Drum Maximum Inside

less than 1.5mm (1/16 inch) above the backing plate or 0.795mm (1/32 inch) above the rivets, or if the lining shows evidence of brake fluid or oil contamination that is causing a brake pull, replace all four shoe and lining assemblies.

3. In checking rotor runout on rear disc brakes it is important not to disturb the rear axle bearing setting.
4. Clamp a dial indicator TOOL-4201-C, or equivalent to the spindle so the stylus contacts the rotor approximately one inch from the outer edge. Rotate the rotor and take an indicator reading. If the reading exceeds 0.254mm (0.010 inch) total lateral runout within a six inch radius on the indicator, replace or re-surface the disc brake rotor. **The following requirements must be met when re-surfacing disc brake rotors.**

   Use a disc brake lathe to re-finish the disc brake rotors. (Follow the manufacturers instructions.)

No more than 0.508mm (0.020 inch) of material may be machined equally off each surface. If rotor thickness falls below the minimum shown on each rotor, it must be replaced. Refer to the specifications at the end of Section 12-24, Disc Brakes, for maximum rotor brake surface lateral runout, thickness variation, and surface finish.

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When the runout check is finished, adjust the bearings as described in Section 11-10, Wheel Hubs and Bearings—Front (except Front Wheel Drive) to prevent bearing failure.

5. Check the rotor for scoring. Remove minor scores with a fine emery cloth. If the rotor is excessively scored, re-finish or replace the rotor if necessary. If either the rotor or the hub assembly needs replacing, see Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper, for proper procedure.
6. Check the caliper. If it is cracked or shows any signs of leakage, replace it. If the caliper is leaking around the dust boot, remove and repair it.
7. Check brake hoses for signs of cracking, leaks or abrasion. Replace them, if necessary.

Brake Cylinder

1. Clean all brake cylinder parts in clean isopropyl alcohol or use the Rotunda Brake Parts Washer model 065-00016 or equivalent. Inspect all parts for wear or damage. Check the cylinder bore for rust, scores, or other damage. Be sure the bleeder screw passage is clean and open. Replace all parts that are worn or damaged.
2. If dirt is found in any part of the hydraulic system, flush the entire system with clean isopropyl alcohol.

Master Cylinder

1. Clean all master cylinder parts in clean isopropyl alcohol, or use the Rotunda Brake Parts Washer model 065-00016 or equivalent and inspect the parts for wear or damage. Replace them if required. **When a master cylinder repair kit is used, follow the instructions in the kit and install all of the parts provided.**
2. Make sure that all ports and vents in the master cylinder are open and free of foreign matter.

Brake Drums and Linings

1. Remove all wheels and drums from the vehicle, and inspect the drums and brake shoe linings for wear or damage that would affect brake operation. **Do not let brake fluid, oil or grease touch the drum or linings.**
2. Re-line any brake shoe that is worn to within 0.794mm (1/32 inch) of any rivet head, or when the lining is soaked with brake fluid, oil, or grease. **If a worn lining is not replaced, the brake drum may become severely damaged. Always replace the primary and secondary brake shoe lining assemblies on both front or both rear brake assemblies at the same time.**
3. Before relining a brake shoe, inspect the shoe for distortion, cracks, elongated rivet holes, or looseness between the rim and web. If any of these conditions are visible, replace the shoe. **Do not attempt to repair a damaged brake shoe.**
4. If the drum and linings are in good condition, install the wheel and drum. **The condition of the drums and linings of the opposite wheel will usually be about the same as the wheel that was removed.**
5. Fill the master cylinder reservoir with the specified brake fluid to within 6.35 mm (1/4 inch) of the top of the filler neck.
6. Be sure that the parking brake is fully released before making any brake adjustment.
7. On brake assemblies with an adjustable anchor pin, check the front brake anchor pin nut with a wrench. If the nut is loose, tighten it to 109-135 N·m (80-100 ft-lbs).

SPECIFICATIONS

SPECIAL TOOLS

Number	Description	Application
T73L-2196-A	Disc Brake Piston Remover	Use with Slide Hammer
D79L-2196-A	Disc Brake Pad Spreader	Universal
T73T-2300-A	Hold Down Spring Tool	F-150 thru F-350
TOOL-4201-C	Dial Indicator	Universal

CH2700-2J

ROTUNDA EQUIPMENT

Model Number	Description
104-00064	Brake Bleeder
021-00014	Vacuum Tester
091-00001	Brake and Clutch Service Vacuum
065-00016	Brake Parts Washer
059-00008	Vacuum and Pressure Tester

CH3537-1E

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SECTION 12-02 Drum Brakes—Single Cylinder, Dual Piston

SUBJECT	PAGE
ADJUSTMENTS	
Rear Brake Shoe Adjustment	12-02-1
Self Adjusting Drum	12-02-1
With Drums Installed	12-02-1
With Drums Removed	12-02-1
DESCRIPTION	12-02-1
DIAGNOSIS AND TESTING	12-02-1
DISASSEMBLY AND ASSEMBLY	
Brake Wheel Cylinder	12-02-10
REMOVAL AND INSTALLATION	
Brake Shoe Adjusting Screw	12-02-7
Web Ledge Design-Rear—E-250-E-350, F-250 and F-350	12-02-7
REMOVAL AND INSTALLATION (Cont'd)	
Brake Shoe and Adjusting Screw	12-02-6
F-150, E-150 and Bronco	12-02-6
Brake Wheel Cylinder	12-02-8
Rear Brake Backing Plate	12-02-8
Rear Brake Drum	12-02-5
Bronco, F-150—F-250—F-350, E-150—E-250—E-350	12-02-5
SAFETY	
Breathing Asbestos Dust	12-02-4
SPECIFICATIONS	12-02-10
VEHICLE APPLICATION	12-02-1

VEHICLE APPLICATION

Bronco, E-150 Through E-350, F-150 Through F-350 (4x2), F-150 Through F-350 (4x4) Vehicles

DESCRIPTION

The rear brakes are drum type with internal expanding shoes. The rear drum brakes are of the single anchor type, mounted to the same anchor, and actuated by one wheel cylinder. The wheel cylinder has two pistons. One piston exerts force against the upper end of the primary shoe; the other piston exerts force against the upper end of the secondary shoe.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service, for drum brake diagnosis and testing procedures.

ADJUSTMENTS

Rear Brake Shoe Adjustment

The rear brake shoes are automatically adjusted when the vehicle is driven forward and reverse and the brakes applied several times sharply. Manual brake adjustment is required only after the brake shoes have been relined or replaced. Perform the manual adjustment with the drums removed, using the tool and the procedure described below. Refer to Figs. 1 and 2 for typical brake system installations.

When adjusting the rear brake shoes, check the parking brake cables for proper adjustment. Make sure the equalizer operates freely.

With Drums Removed

1. With drums removed, clean away all rust and dirt on the points where the shoes touch the backing plate.
2. Apply a small amount (1/32 inch thick) of Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent or Disc Brake Caliper Slide Grease, D7AZ-19590-A (ESA-M1C172-A) or equivalent to the ledges where the shoes touch the backing plate. Be careful not to get the lubricant on the linings. Also lubricate the adjusting cable eye and the anchor pin area.
3. Use a brake shoe adjustment gauge Tool D81L-1103-A or equivalent: for E-150, F-150 and Bronco. For the following vehicles, use Rotunda Model 104-00063 or equivalent: E-250—E-350 and F-250—F-350 (Fig. 3). Adjust to the inside diameter of the drum braking surface.
4. Reverse the tool as shown in Fig. 4 and adjust the brake shoes until they touch the gauge. The gauge contact points on the shoes (Fig. 4) must be parallel to the vehicle with the center line through the center of the axle. Hold the automatic adjusting lever out of engagement while rotating the adjusting screw, to prevent burring the screw slots. Make sure the adjusting screw rotates freely. If necessary, lubricate the adjusting screw threads with a thin, uniform coating of lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
5. Install the drums. Install the retaining nuts and tighten securely.
6. Install the wheels on the drums and tighten the mounting nuts to specification, as listed at the end of this Section.
7. Complete the adjustment by applying the brakes sharply several times while driving the vehicle in reverse.
8. After adjusting the brake shoes, check brake operation by making several stops while driving forward.

With Drums Installed

Adjust the single anchor brake by turning an adjusting screw located between the lower ends of the shoes (Figs. 5 and 6).

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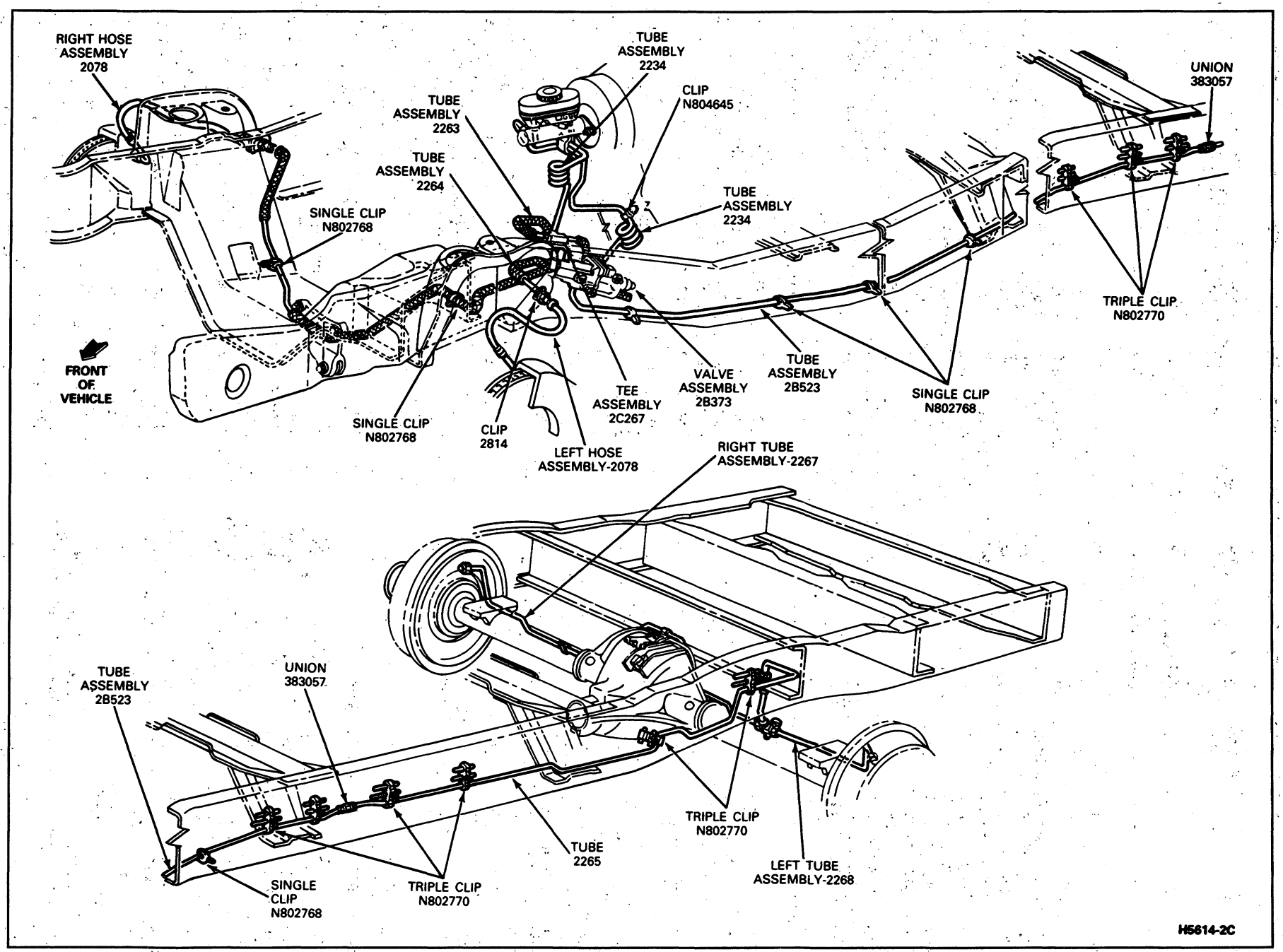


FIG. 1 Brake System—F-150—F-350 and Bronco—Typical

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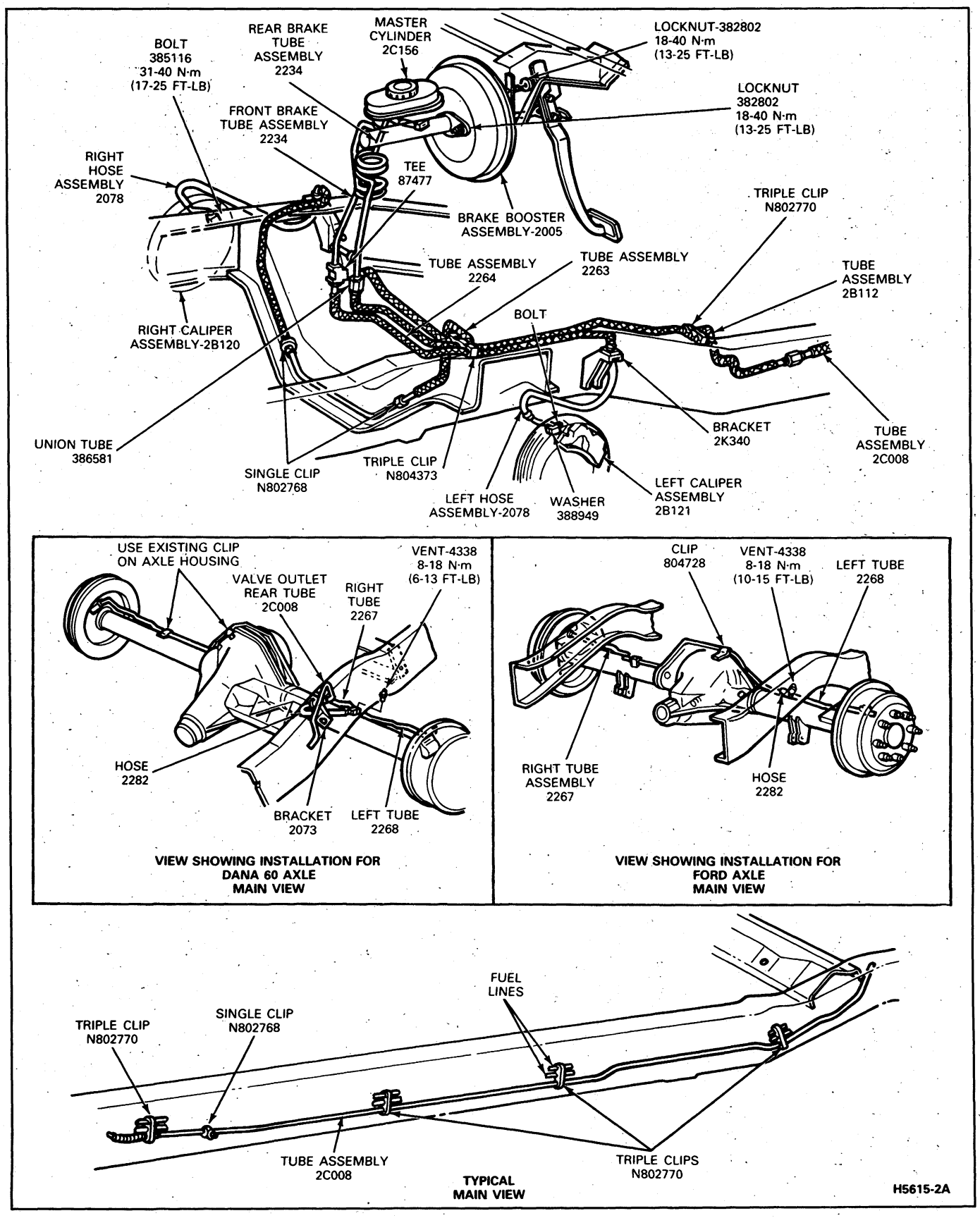


FIG. 2 Brake System—E-150—E-350—Typical

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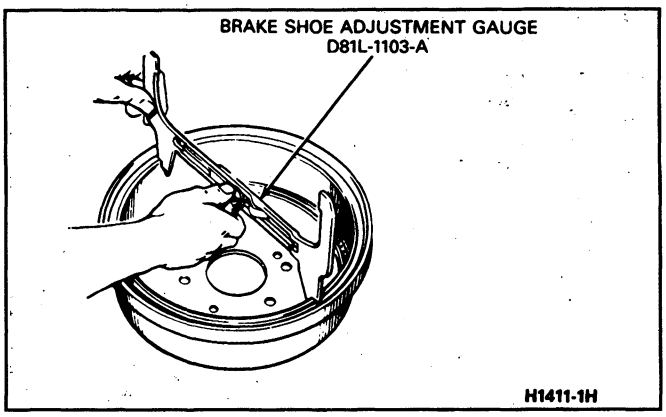


FIG. 3 Measuring Drum

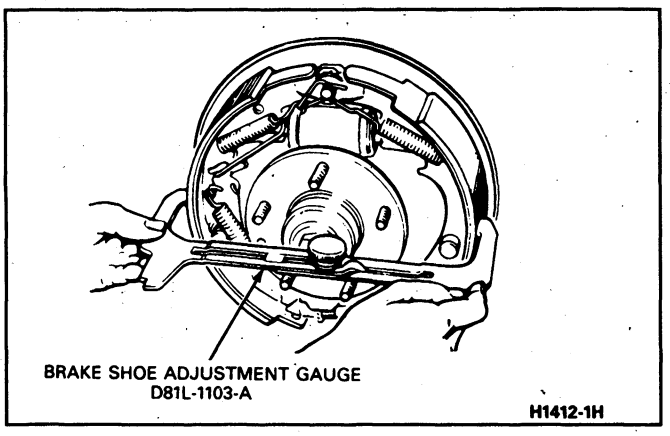


FIG. 4 Measuring Shoes

1. Raise the vehicle until the tires clear the floor. Install safety stands under the axle.
2. Remove the cover from the adjusting hole at the bottom of the brake backing plate, and turn the adjusting screw (inside the hole) to expand the brakes shoes until they drag against the brake drum as shown in Figs. 5 and 6.
3. When the shoes are against the drum, loosen the adjusting screw an additional 10 to 12 notches so that the drum rotates freely without drag (Fig. 5). If the drum does not rotate freely, remove the wheel and drum, and vacuum out any dust and dirt from the linings. Using sand paper, remove any rust from the points where the shoes touch the backing plate. Apply a light coating of lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, Disc Brake Caliper Lubricant, D7AZ-19590A (ESA-M1C172A) or equivalent. Do not get the lubricant on the linings. Install the wheel and drum and adjust the shoes.
4. Install the adjusting hole cover on the brake backing plate.
5. Check and adjust the other brake assembly.
6. Apply the brakes. If the pedal travels more than halfway to the floor, there is too much clearance between the brake shoes and the drums. Repeat Steps 2 and 3 above.
7. When all brake shoes have been properly adjusted, lower the vehicle and road test to check brake operation. Perform the road test only when the brakes will apply and the vehicle can be safely stopped.

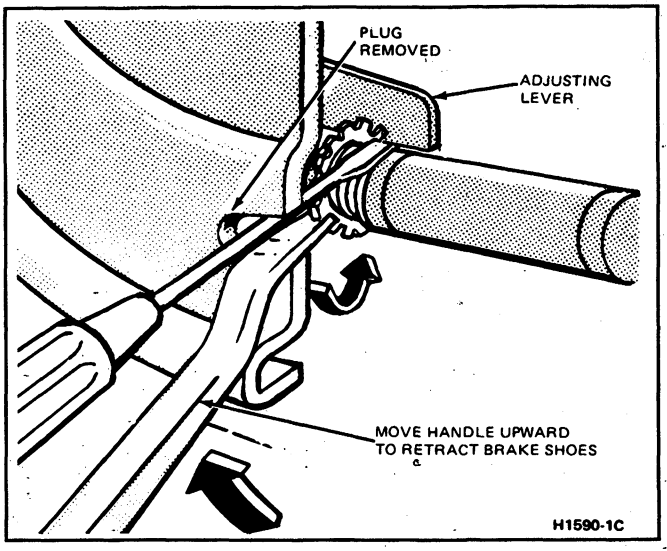


FIG. 5 Backing Off Brake Adjustment—E-150, F-150 and Bronco

SAFETY

Breathing Asbestos Dust

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

The following procedures are recommended to minimize asbestos dust exposures during brake and clutch servicing of trucks, tractors and trailers. These procedures are consistent with asbestos regulations set forth by the Occupational Safety and Health Administration (OSHA). Adherence to these procedures will eliminate exposures to asbestos during brake and clutch servicing.

An area should be designated for all brake and clutch services. Entrances to this area must be posted with the following sign:

ASBESTOS

Dust Hazard

Avoid Breathing Dust

Wear Assigned Protective Equipment

Do Not Remain in Area Unless Your Work Requires It

Breathing Asbestos Dust May Cause

Asbestosis and Cancer

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Only essential personnel should be present in the immediate maintenance area during brake and clutch servicing.

During brake servicing, use a toxic dust air purifying respirator of either single-use or replaceable cartridge type. It must be approved by the Mine Safety and Health Administration (MSHA) or by the National Institute of Occupational Safety and Health (NIOSH). It shall be worn during all procedures from removal of wheels to reassembly. An example of an acceptable respirator is the 3M-9910 or 9920 (or equivalent).

Wheel brake assemblies must be cleaned carefully using a vacuum cleaner recommended for use with asbestos fibers. A vacuum for this purpose is available from the Rotunda Equipment Catalog, model number 091-00001 or equivalent. Similar vacuums are also manufactured by Nilfish and Hako ("Minuteman"). If additional cleaning is necessary, a rag soaked with water or Rotunda Brake washer Model 065-00016 or equivalent must be used.

Grinding or sanding on brake linings, pads, rotors or drums, shall be done only while using properly exhaust-ventilated equipment. A respirator must be worn while performing these operations.

During removal of vacuum bags, an approved respirator, as described above, shall be worn. Industrial vacuum cleaner bags containing asbestos dust, cloths used for wiping brake assemblies, and other asbestos-contaminated debris shall be sealed in plastic bags and labeled with the following warning label printed in letters of sufficient size and contrast to be readily visible and legible:

CAUTION

Contains Asbestos Fibers

Avoid Breathing Dust

Breathing Asbestos Dust May Cause

Asbestosis and Cancer

All asbestos waste must be disposed of in accordance with OSHA and Environmental Protection Agency (EPA) asbestos regulations. Asbestos waste must not be incinerated or disposed of in community water supplies.

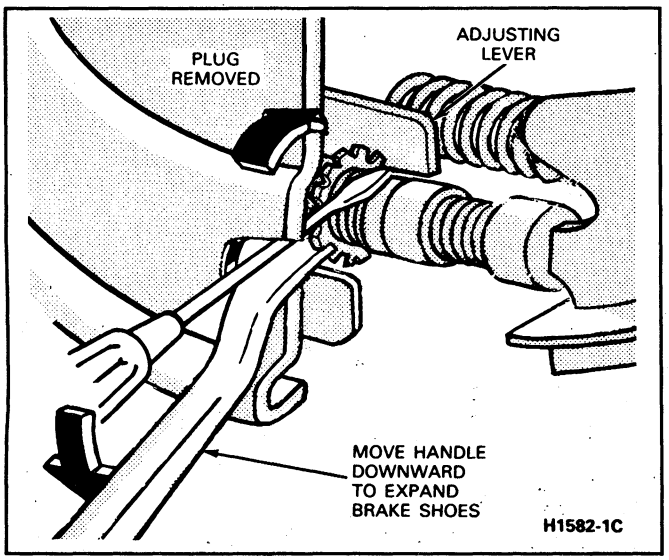


FIG. 6 Expanding Brake Shoes—F-250—F-350, E-250—E-350 Rear

All floor cleaning in the asbestos servicing area and clean-up of waste from grinding or sanding must be done using an approved vacuum cleaner while wearing a proper respirator.

REMOVAL AND INSTALLATION

Rear Brake Drum

Bronco, F-150—F-250—F-350, E-150—E-250—E-350

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

Removal

1. Raise the vehicle so the wheel and tire assembly is clear of the floor and install safety stands under the axle.
2. Remove the hub cap if equipped, and wheel and tire assembly. Remove the spring retaining nuts and remove the brake drum.
3. Check the brake surface drum runout. If surface is worn or run out exceed the specifications, the drum should be turned.

   If the brake drum will not come off, insert a narrow screwdriver through the brake adjusting hole in the backing plate, and disengage the adjusting lever from the adjusting screw. While holding the adjusting lever away from the adjusting screw, loosen the adjusting screw with the Brake Adjusting Tool D81L-1103-C or equivalent. **Loosen the adjusting screw only if the drum cannot be removed. Do not burr, chip, or damage the notches in the adjusting screw or the self adjusting mechanism will not function properly.**

   If the adjusting screw was loosened, check to be sure the adjusting lever is still properly seated in the shoe web.

Installation

1. Remove the protective coating from a new drum with carburetor degreaser.
2. Adjust the brakes as described in this Section.
3. Install the drum onto the axle shaft flange or hub assembly.
4. Install the brake drum retaining nuts and tighten securely. Install the wheel on the axle shaft flange or hub studs against the drum, and tighten the

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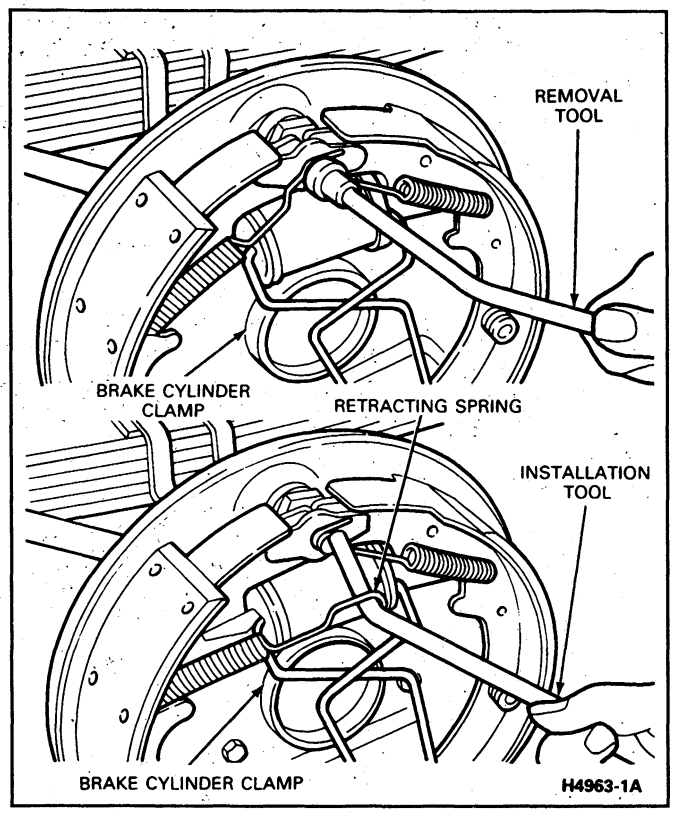


FIG. 7 Spring Replacement—Typical

wheel retaining nuts to specification listed at the end of this Section.

Brake Shoe and Adjusting Screw

F-150, E-150 and Bronco

Removal

1. Remove the wheel and drum and install a clamp over the ends of the brake cylinder as shown in Fig. 7.
2. Contract the shoes as follows:
   a. Disengage the adjusting lever from the adjusting screw by pulling backward on the adjusting lever cable (Fig. 8).
   b. Move the outboard side of the adjusting screw upward and back off the pivot nut as far as it will go.
3. Pull the adjusting lever, cable and automatic adjuster spring down and toward the rear to unhook the pivot hook from the large hole in the secondary shoe web. **Do not pry the pivot hook out of the hole.**
4. Remove the automatic adjuster spring and adjusting lever.
5. Remove the secondary shoe-to-anchor spring using a brake spring removal/installation tool (Fig. 7). Using the same tool, remove the primary shoe-to-anchor spring and unhook the cable anchor. Remove the anchor pin plate (if equipped).
6. Remove the cable guide from the secondary shoe (Fig. 8).
7. Remove the shoe hold-down springs, shoes, adjusting screw, pivot nut, and socket. **Note the color and position of each hold-down spring.**

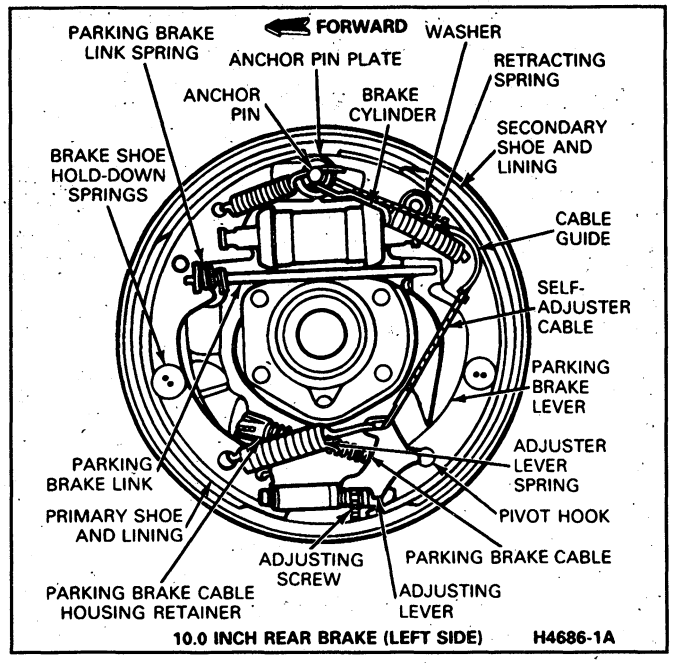


FIG. 8 Self Adjusting Brake Assemblies Standard—F-150 and E-150 Rear and Bronco

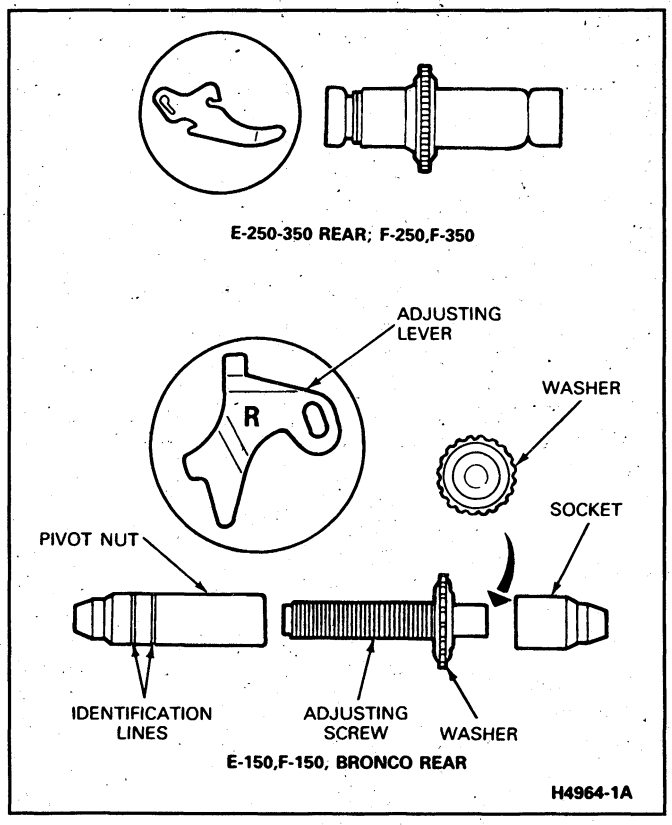


FIG. 9 Adjusting Screw and Lever Bronco, E and F Series-150-350 Rear

They must be re-assembled in the same position.

8. Remove the parking brake link and spring. Disconnect the parking brake cable from the parking brake lever.
9. Remove the brake secondary shoe and disassemble the parking brake lever from the shoe

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by removing the retaining clip and spring washer (Fig. 8).

Installation

1. Clean the ledge pads on the backing plate. Sand lightly to bare metal.
2. Apply a light coating (1/32 inch thick) of high temperature lithium-base grease Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A), or equivalent at the points where the brake shoes touch the backing plate. Also lubricate the adjusting cable eye and the anchor pin area.
3. Before installing the rear brake shoes, assemble the parking brake lever on the secondary shoe and secure with the spring washer and retaining clip.
4. Position the brake shoes on the backing plate, and install the hold-down spring pins, springs, and cups. Install the parking brake link, spring, and washer. Connect the parking brake cable to the parking brake lever (Fig. 8).
5. Install the anchor pin plate, (if equipped), and place the cable anchor over the anchor pin with the crimped side toward the backing plate.
6. Install the primary shoe-to-anchor spring using a brake spring removal/installation tool (Fig. 7).
7. Install the cable guide on the secondary shoe with the flanged hole fitted into the hole in the secondary shoe. Thread the cable around the cable guide groove (Fig. 8).

   Be sure the cable is positioned in this groove, and not between the guide and the shoe web.
8. Install the secondary shoe-to-anchor (long) spring (Fig. 8).

   Be sure the cable end is not cocked or binding on the anchor pin when installed. All parts should be flat on the anchor pin. Remove the brake cylinder clamp.
9. Apply a lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, or Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A) or equivalent, to the threads and the socket end of the adjusting screw. Turn the adjusting screw into the adjusting pivot nut to the end of the threads and then loosen it one-half turn.

   Install the adjusting screw assembly in the same location from which it was removed. Interchanging the brake shoe adjusting screw assemblies from one side of the vehicle to the other will cause the brake shoes to retract rather than expand each time the automatic adjusting mechanism is operated. To prevent incorrect installation, the socket end of each adjusting screw is stamped with R or L (Fig. 9) to indicate their installation on the right or left side of the vehicle. The adjusting pivot nuts can be distinguished by the number of lines machined around the body of the nut. Two lines indicate a right hand nut; one line indicates a left hand nut.
10. Place the adjusting socket on the screw and install the assembly between the shoe ends with the adjusting screw nearest the secondary shoe.
11. Hook the cable hook into the hole in the adjusting lever from the outboard plate side. The adjusting levers are also stamped with an R or L to indicate their installation on the right or left hand brake assembly (Fig. 9).
12. Place the hooked end of the adjuster spring in the large hole in the primary shoe web, and connect the loop end of the spring to the adjuster lever hole.
13. Pull the adjuster lever, cable and automatic adjuster spring down toward the rear to engage the pivot hook in the large hole in the secondary shoe web (Fig. 8).
14. After installation, check the action of the adjuster by pulling the section of the cable between the cable guide and the adjusting lever toward the secondary shoe web far enough to lift the lever past a tooth on the adjusting screw wheel. The lever should snap into position behind the next tooth, and releasing the cable should cause the adjuster spring to return the lever to its original position. This return action of the lever will turn the adjusting screw one tooth.

    If pulling the cable does not produce the action described, or if lever action is sluggish instead of positive and sharp, check the position of the lever on the adjusting screw toothed wheel. With the brake in a vertical position (anchor at the top), the lever should contact the adjusting wheel one tooth above the center line of the adjusting screw. If the contact point is below this center line, the lever will not lock on the teeth in the adjusting screw wheel, and the screw will not be turned as the lever is actuated by the cable.

    To find the cause of this condition:

    a. Check the cable end fittings. The cable should completely fill or extend slightly beyond the crimped section of the fittings. If this does not happen, the cable assembly may be damaged, and should be replaced.

    b. Check the cable guide for damage. The cable groove should be parallel to the shoe web, and the body of the guide should lie flat against the web. Replace the guide if it shows damage.

    c. Check the pivot hook on the lever. The hook surfaces should be square with the body on the lever for proper pivoting. Repair the hook or replace the lever if the hook shows damage.

    d. Be sure the adjusting screw socket is properly seated in the notch in the shoe web.

Brake Shoe Adjusting Screw

Web Ledge Design-Rear—E-250-E-350, F-250 and F-350

Removal

1. Raise the vehicle so the wheels clear the floor and install safety stands under the axle.
2. Remove the wheel and drum. If the drum does not clear the brake shoes, retract the brake shoes as shown in Fig. 5.

   Remove the parking brake lever assembly retaining nut from behind the backing plate and remove the parking brake lever assembly (Fig. 10).
3. Remove the adjusting cable assembly from the anchor pin, cable guide, and adjusting lever.

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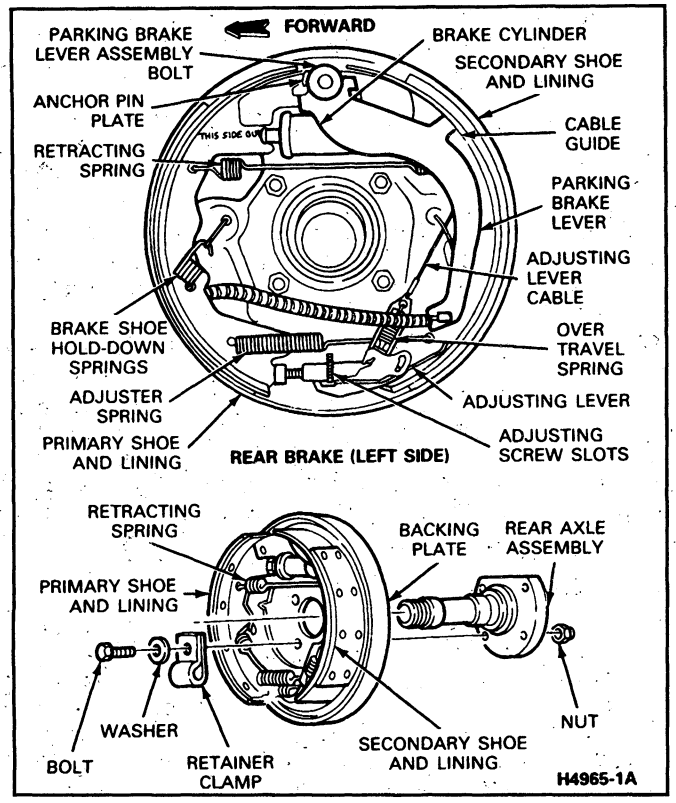


FIG. 10 Self Adjusting Brake Assemblies-Heavy Duty—E-250—E-350, F-250—F-350

4. Remove the brake shoe retracting springs.
5. Remove the brake shoe hold-down spring (use Tool Number T73T-2300-A or equivalent) from each shoe.
6. Remove the brake shoes and adjusting screw assembly.
7. Disassemble the adjusting screw assembly.

Installation

1. Clean the ledge pads on the backing plate. Sand lightly to bare metal.
2. Apply a lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, or Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A) or equivalent to the retracting and hold-down spring contacts on the brake shoes and backing plate.
3. Apply a lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A), or equivalent or to the threads and socket end of the adjusting screw.
4. Install the upper retracting spring on the primary and secondary shoes as shown in Fig. 10, and position the shoe assembly on the backing plate with the wheel cylinder push rods in the shoe slots.
5. Install the brake shoe hold-down springs (Fig. 11). Use tool number T73T-2300-A or equivalent.
6. Install the brake shoe adjustment screw assembly with the slot in the head of the adjusting screw toward the primary shoe. Install the lower retracting spring, adjusting lever spring, adjusting lever assembly, and connect the adjusting cable to the adjusting lever. Position the cable in the cable guide and install the cable anchor fitting on the anchor pin.

   Install the adjusting screw assemblies in the same locations from which they were removed. Interchanging the brake shoe adjusting screw assemblies from one side of the vehicle to the other will cause the brake shoes to retract rather than expand each time the automatic adjusting mechanism is operated. To prevent incorrect installation, the socket end of each adjusting screw is stamped with an R or L (Fig. 9) to indicate their installation on the right or left side of the vehicle. The adjusting pivot nuts can be distinguished by the number of lines machined around the body of the nut. Two lines indicate a right hand nut; one line indicates a left hand nut.
7. Install the parking brake assembly in the anchor pin and secure with the retaining nut behind the backing plate.
8. Adjust the brakes before installing the drums as described in this Section.

Brake Wheel Cylinder

Removal

1. Remove the wheel, drum, and brake shoes. Remove the cylinder-to-shoe connecting links.
2. Disconnect the brake line from the brake cylinder.
3. Remove the brake cylinder retaining bolts and lockwashers, and then remove the cylinder from the backing plate.

Installation

1. Place the brake cylinder on the backing plate and install the retaining bolts and lockwashers.
2. Install a new gasket on the brake line fitting (if equipped) and connect the brake line to the brake cylinder.
3. Install the brake shoes and the connecting links between the shoes and cylinder. Install the drum and the wheel.
4. Adjust the brakes (described in this Section) and bleed the system as described in Section 12-01, General Hydraulic Brake Service. Check pedal operation before moving the vehicle.

Rear Brake Backing Plate

Removal

1. On F-150—F-250, E-150—E-250 and Bronco remove the rear wheel and brake drum. Disconnect the brake line from the brake cylinder and submerge the end of the brake line in a can containing a small amount of brake fluid to prevent air from entering the system. Remove the brake shoes and brake cylinder. Disconnect the parking brake lever from the cable.
2. If the rear backing plate is being removed from a Ford 8.8 inch ring gear axle on a F-150, E-150, Bronco refer to Section 15-08. For the Dana Semi-Float axle installed on a E-250 refer to Section 15-05. Ford Semi-float rear axle for F-250, refer to Section 15-09, Integral Carrier Axle 10.25 Inch Ring Gear. Remove the C-clip in the differential case which holds the axle shaft in place. After the C-clip has been removed, slide the axle shaft out of

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the housing. Remove the backing plate after the axle shaft has been removed.

3. For backing plate removal procedures from a Dana Full Float rear axle installed on E-250 HD; E-350, refer to Section 11-14. For Ford Full Float rear axle for F-250 HD and F-350, refer to Section 15-09 Integral Carrier Axle-10.25 inch Ring Gear. Remove the backing plate after the axle shaft has been removed.

Installation

1. Position the rear backing plate on the retaining bolts in the axle housing flange. Insert the axle shaft assembly into the housing so the splines engage the differential side gear, with the bearing retainer sliding onto the retaining bolts and against the backing plate. Install the retaining nuts through the access hole in the axle shaft flange. On E-250 equipped with Dana semi-float rear axles, install axle shafts after referring to Axle Shaft Installation in Section 15-05 Integral Carrier Axle—Dana. On F-250 vehicles with Ford Semi-Float rear axles, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear. On F-250 HD with Ford Full-Float rear axles, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear. On E-250 HD and E-350 vehicles with Dana Full-Float rear axles, refer to Section 15-05 Integral Carrier Axle—Dana.
2. Install the brake cylinder and brake shoes. On rear brakes, connect the parking brake cable to the lever.
3. Connect the brake line to the brake cylinder and install the wheel and brake drum. Adjust the brake shoes (described in this Section) and bleed air from the system as described in Section 12-01, General Hydraulic Brake Service.

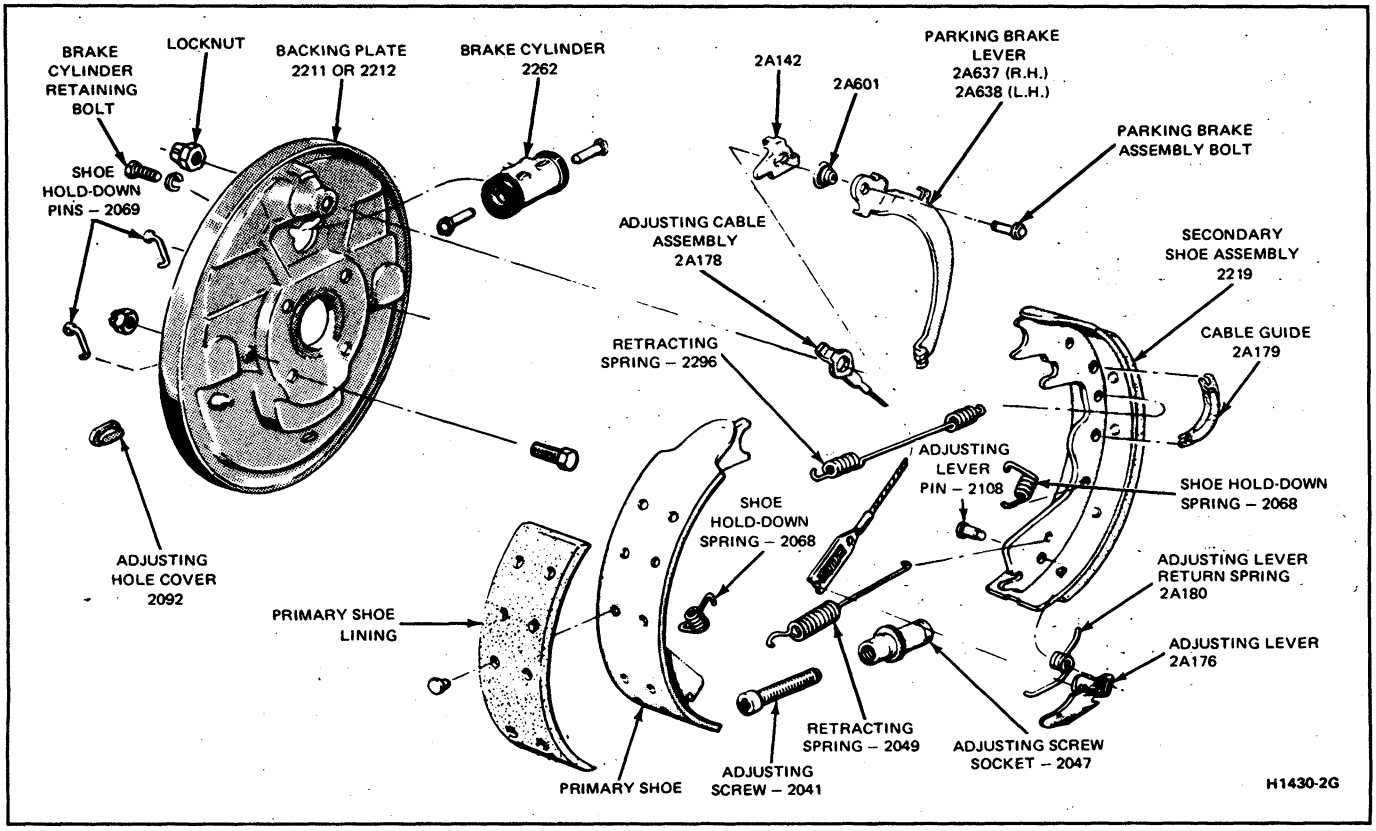


FIG. 11 F-250, F-350 and E-250, E-350 Rear Web Ledge Single Anchor Brake—Disassembled

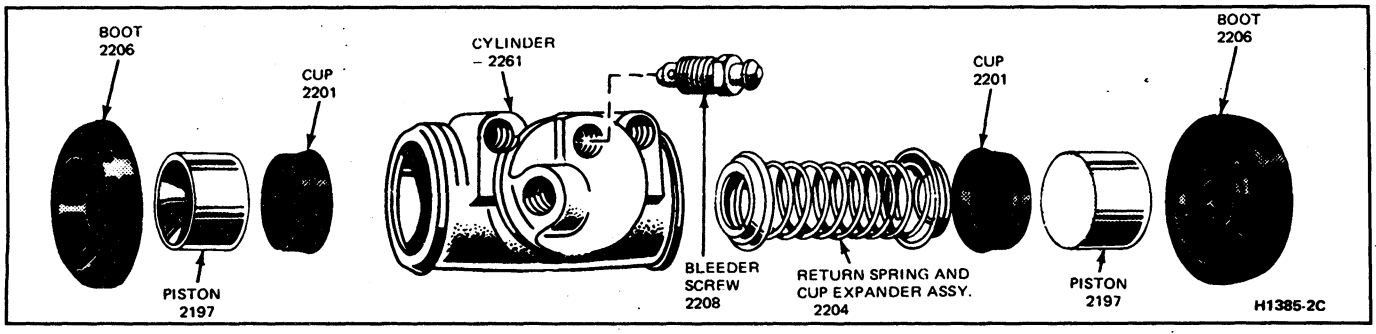


FIG. 12 Double Servo Rear Brake Wheel Cylinder

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DISASSEMBLY AND ASSEMBLY

Brake Wheel Cylinder

Disassembly

1. With the wheel cylinder removed, remove the rubber boots from the ends of the brake cylinder. Remove the pistons, cups, and piston return spring and piston expander assembly from the cylinder (Fig. 12).
2. Remove the bleeder screw from the cylinder.

Assembly

1. Coat all brake cylinder parts with clean Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or equivalent.
2. Install the bleeder screw (Fig. 12) in the brake cylinder.
3. Place the piston return spring and piston expander assembly, cups, and pistons in the cylinder bore, and install a boot and link over each end of the cylinder. Clamp the brake cylinder pistons against the ends of the cylinder. **When using a brake cylinder repair kit follow the instructions in the kit and use all of the parts provided.**

SPECIFICATIONS

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2D

SPECIAL SERVICE TOOLS

Number	Description	Application
T73T-2300-A	Hold Down Spring Tool	F-150 thru F-350
D81L-1103-A	Brake Shoe Adjusting Gauge	Universal
D81L-1103-C	Brake Adjustment Tool	Universal
T85T-4252-AH	Locknut Wrench	F-250, F-350

CH2706-2K

ROTUNDA EQUIPMENT

Model Number	Description
091-00001	Brake and Clutch Service Vacuum
065-00016	Brake Parts Washer
104-00063	Brake Shoe Adjusting Gauge
108-00078	Bearing Packer

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SECTION 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper

SUBJECT	PAGE
ADJUSTMENTS	
Disc Brake Shoe Adjustment	12-24-6
Hydraulic System Bleeding	12-24-6
DESCRIPTION AND OPERATION	
HD (Heavy Duty) Pin Rail Slider Caliper Disc Brakes	12-24-1
LD (Light Duty) Pin Rail Slider Caliper Disc Brakes	12-24-1
DIAGNOSIS AND TESTING	
Disc Brake Rotor	12-24-2
DISASSEMBLY AND ASSEMBLY	
Disc Brake Caliper—HD Rail Sliding Caliper	12-24-11
Disc Brake Caliper—Sliding Caliper—LD	12-24-12
REMOVAL AND INSTALLATION	
Disc Brake Hub and Rotor	12-24-10
HD Pin Rail Slider Caliper, Brake Shoes and Linings	12-24-7
Hydraulic Line Repair	12-24-11
LD Pin Rail Sliding Caliper, Brake Shoes and Linings	12-24-9
SAFETY	
Breathing Asbestos Dust	12-24-7
SPECIFICATIONS	12-24-13
VEHICLE APPLICATION	12-24-1

VEHICLE APPLICATION

F-150—F-350 (4x2), (4x4), E-150—E-350, Bronco and F-Super Duty.

DESCRIPTION AND OPERATION

HD (Heavy Duty) Pin Rail Slider Caliper Disc Brakes

F-250—F-350 (4x2), (Fig. 1), E-250—E-350, (Fig. 3) and F-250—F-350 (4x4), (Fig. 4), model trucks are equipped with dual piston, pin rail slider caliper disc brakes in the front, and conventional drum brakes in the rear. The system has a dual master cylinder and vacuum booster. F-Super Duty series vehicles, (Fig. 5), are equipped with dual piston, pin rail slider caliper disc brakes in the front and rear. The system uses a dual master cylinder and a Hydro-Boost.

The disc brake is of the pin rail slider caliper design, with two pistons on the same side of the rotor. The unit consists of a caliper which slides on two pins that also attach the caliper to the spindle (or anchor plate on F-Super Duty rear disc brakes).

The caliper contains the two pistons. The pistons and cylinder bores are protected by boot seals fitted to a groove in the piston and a groove in the cylinder housing. The spindle mounting positions the caliper assembly over the rotor rearward.

LD (Light Duty) Pin Rail Slider Caliper Disc Brakes

The disc brake assembly used on F-150 (Fig. 7), E-150 (Fig. 2), and Bronco and F-150 (4x4) vehicles (Fig. 6) is a pin rail sliding caliper, single piston type and attaches to its supporting member similarly to the dual piston pin rail slider design.

The ends of the inner shoe and lining assembly are confined within the spindle assembly. An anti-rattle clip is positioned between the shoe and spindle assembly at the bottom of the caliper. The outer shoe flange bearing rests against the shoe locating and torque surfaces on the caliper housing.

The linings are riveted to the shoes. The inner and outer shoes are not interchangeable.

The caliper housing is a single piece finished casting positioned on the spindle (knuckle on 4x4) assembly.

Pins are inserted between the machined surfaces of the caliper and spindle assemblies (View Z, Fig. 6). These pins retain the calipers to the spindle assemblies.

A single hydraulic piston is located in the cylinder bore in the caliper housing, with the hydraulic fluid inlet at the bottom of the bore. A square section seal fitted into an annular groove in the caliper cylinder bore, and a rubber boot seal the piston and caliper bore from road splash and contamination. A bleeder screw located above the cylinder bore is used to bleed air from the system.

For F-150—F-350 (4x2), and E-150—E-350 with SRW (Single Rear Wheels), the hub and ventilated rotor is an integrally cast assembly. The F-150—F-350 (4x4) and the E-350 and F-350 with DRW (Dual Rear Wheels) and F-Super Duty series vehicles utilize separate hub and rotor assemblies which are bolted together. A single piece splash shield, bolted to the spindle, protects the bearings and inboard surface of the rotor from road splash. The wheel protects the outboard surface of the rotor and brake assembly.

When the brake pedal is depressed, brake fluid from the master cylinder passes into the caliper cylinder. This moves the piston outward and forces the inner shoe and lining assembly against the inboard surface of the rotor.

The inner lining pressing against the rotor moves the caliper housing slightly inboard. The outer legs of the caliper housing force the outer shoe and lining assembly against the outboard surface of the rotor.

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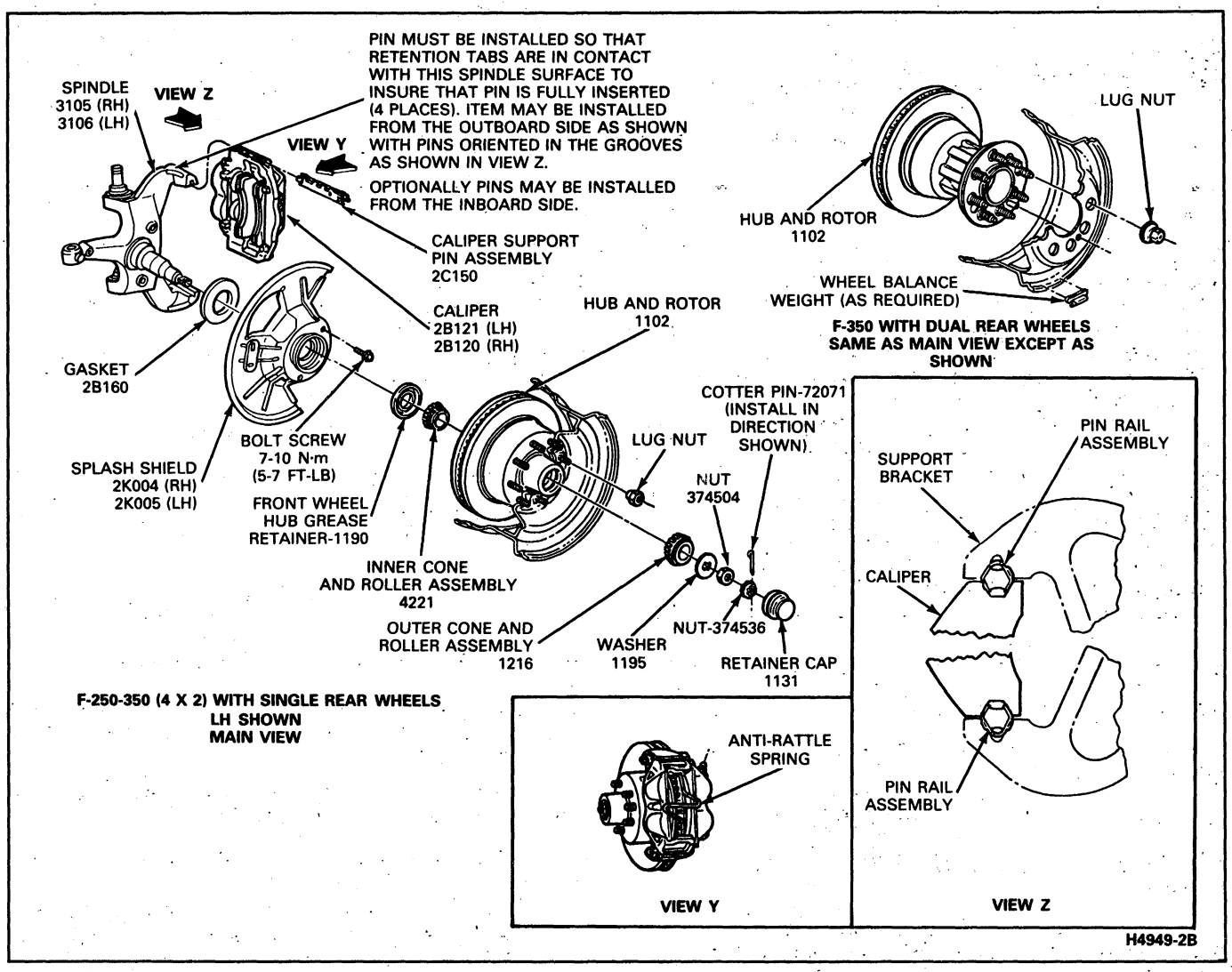


FIG. 1 Disc Brake—F-250 (Above 6900 GVWR)—F-350, (4x2)

The two shoe and lining assemblies clamp the rotor in a vise-type movement to provide the braking action. Braking torque is transferred from the linings to the shoes. For F-150, torque from the inner shoe is transferred directly to the spindle (knuckle on 4x4) assembly, while the torque from the outer shoe is transferred through the caliper to the spindle (knuckle on 4x4) assembly.

When the brake pedal is released, the piston seal retracts the piston into the cylinder, and the caliper housing slides slightly outboard, releasing the brakes.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service, for disc brake diagnosis and testing procedures not covered below.

Disc Brake Rotor

Each time the brakes are serviced, the disc brake rotor should be checked for scoring, runout, parallelism and thickness.

Rotor scoring and runout may be checked on most brakes with the caliper either on or off. To check parallelism and thickness, the caliper must be removed.

Rotor specifications are listed in the Specifications at the end of this Section.

Rotor Runout

Rotor runout is the side-to-side movement or wobble of the rotor as it rotates. Excessive runout may cause vibration, pedal pumping or brake chatter. Use the following procedure to check rotor runout.

1. Tighten the spindle nut (front brakes only) to eliminate all end play from the bearings. Be sure the hub and rotor can be turned. Do not disturb the rear bearing setting when measuring rear rotor runout.
2. Attach a dial indicator TOOL-4201-C, or equivalent to some part of the vehicle suspension so the stylus of the indicator touches the surface of the rotor approximately one inch from outer edge of the rotor as shown in Fig. 8.

   NOTE: Installing the wheel nuts helps to obtain more accurate readings on two-piece (bolted) hub and rotor assemblies.
3. Set the dial indicator to zero, slowly turn the rotor one complete turn and note the high and low readings on the dial. The total between the high

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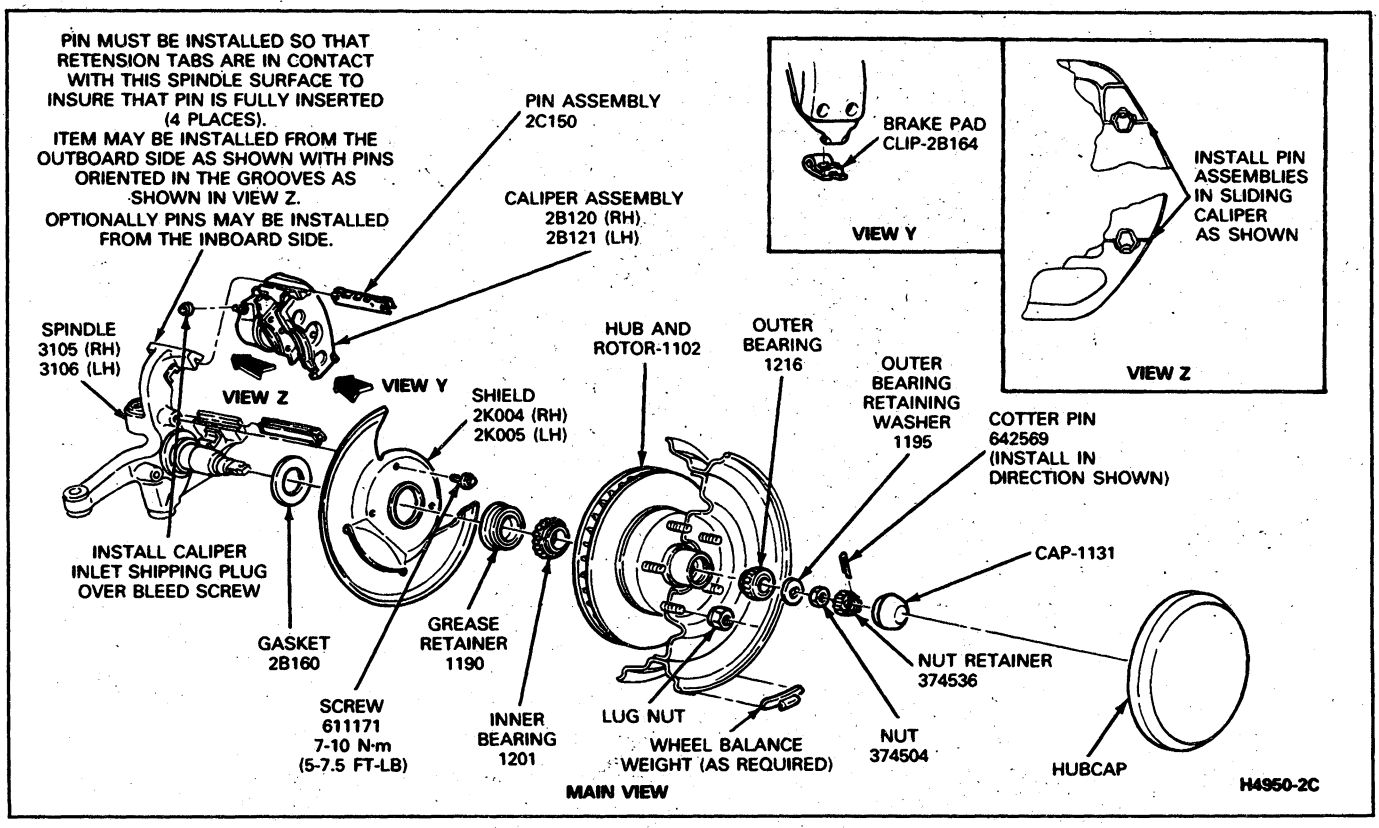


FIG. 2 Disc Brake System—E-150

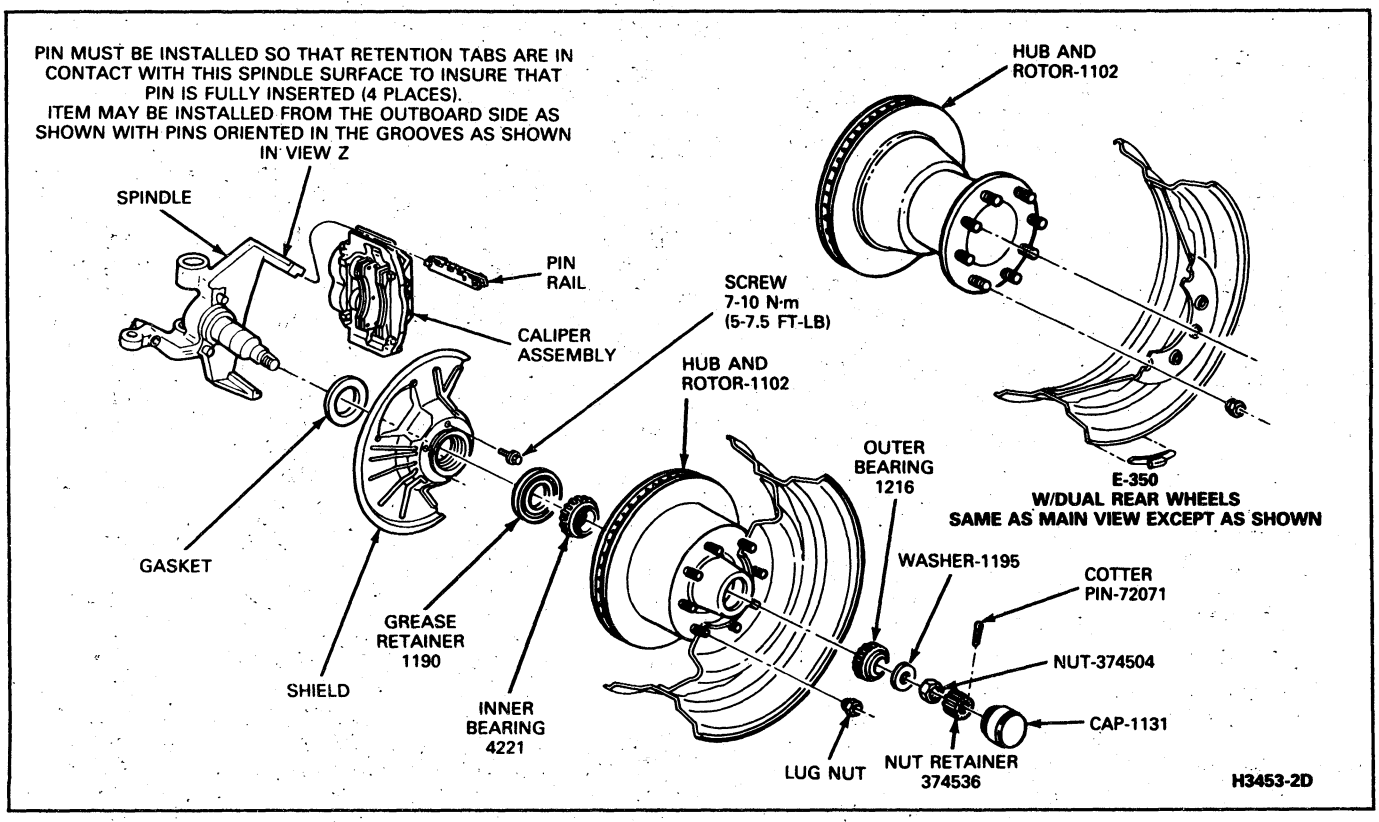


FIG. 3 Disc Brake System—E-250—E-350

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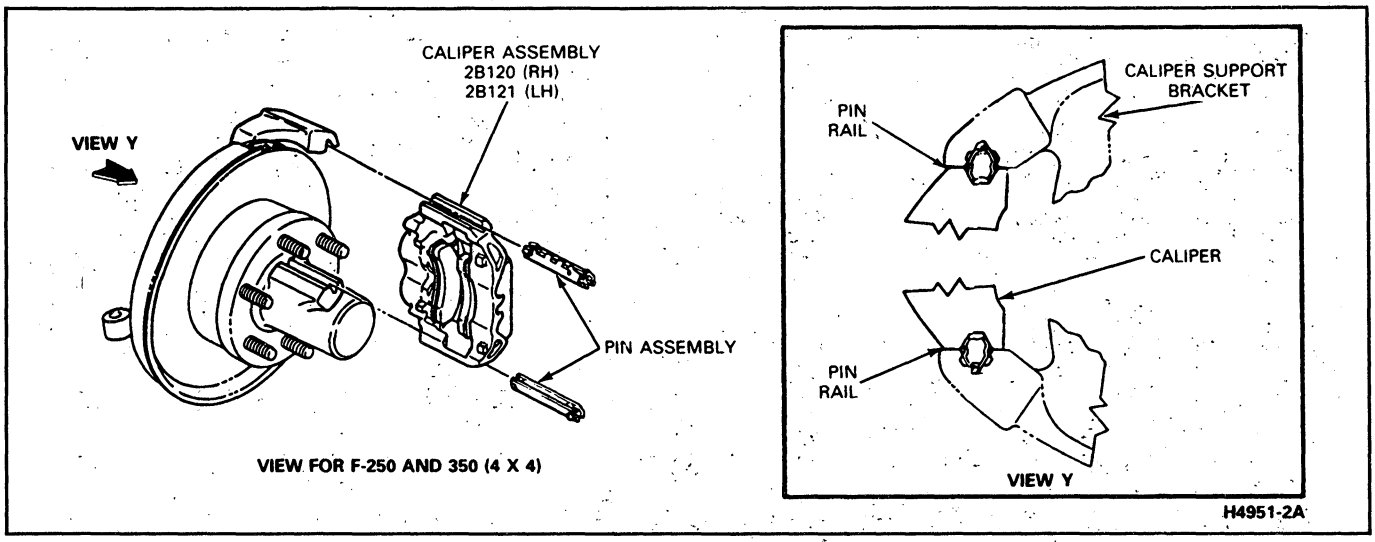


FIG. 4 Disc Brake System—F-250, F-350 (4x4)

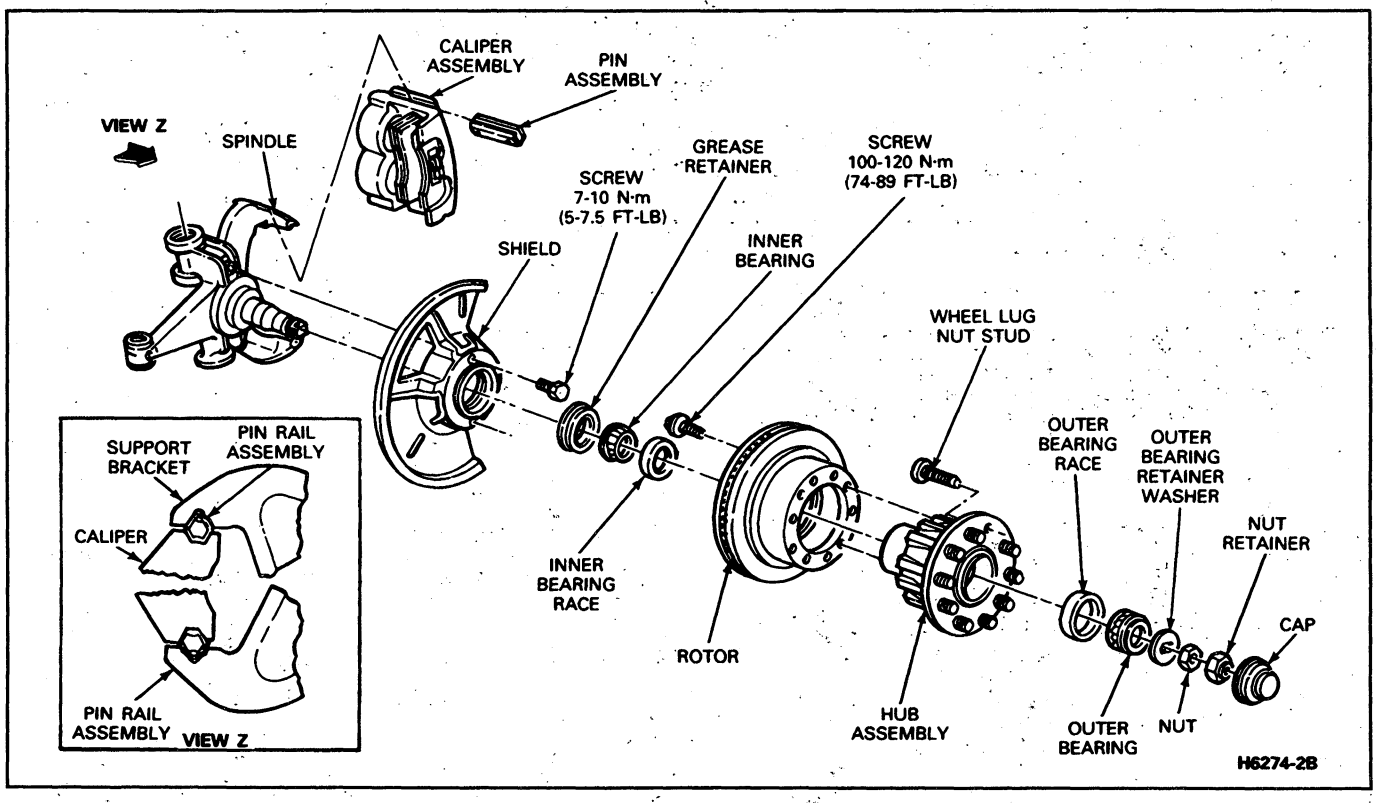


FIG. 5 Disc Brake System—F-Super Duty Chassis Cab, Stripped Chassis and Motor Home Chassis—Typical

and low reading must not exceed the specified runout limit.

4. Refinish or replace the rotor as required.

CAUTION: Be sure to adjust the spindle nut to specifications after the runout check.

Parallelism

Parallelism is the variations in the thickness of the rotor. If the two rubbing surfaces of the rotor are not parallel, the rotor may cause excessive pedal travel, a pulsating pedal, or noise.

Two methods can be used to check if the two faces of a rotor are parallel. A micrometer can be used to measure the rotor thickness at 12 points approximately 30 degrees apart and one inch from the outer edge of the rotor.

The other method is to measure the rotor on a precision lathe designed for machining disc brake rotors. Attach two dial indicators, one on each side of the rotor, so that the stylus of each indicator contacts the rubbing surface, directly opposite each other, approximately one inch from the outer edge of the rotor.

Zero both indicators and rotate the rotor while watching both dials. If the total readings of both indicators exceed the specified limit for parallelism, the rotor must be refinished or replaced.

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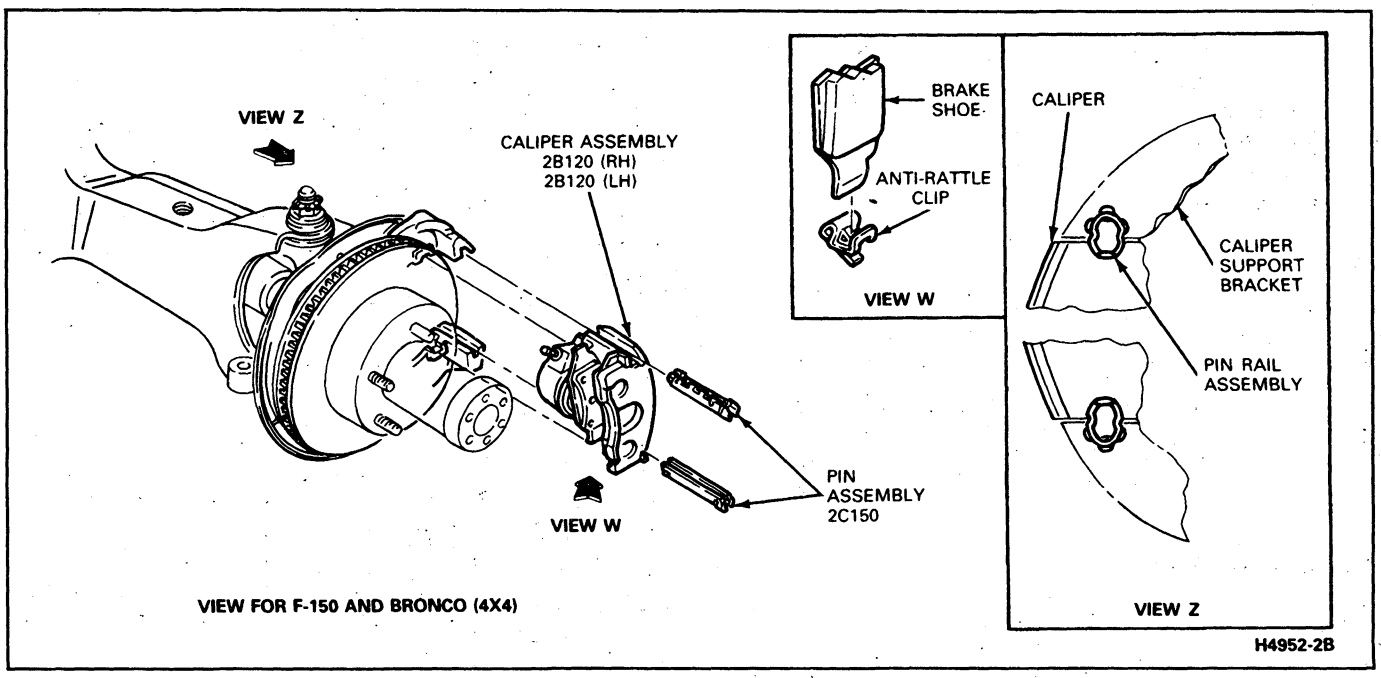


FIG. 6 Disc Brake System—F-150, (4x4) and Bronco

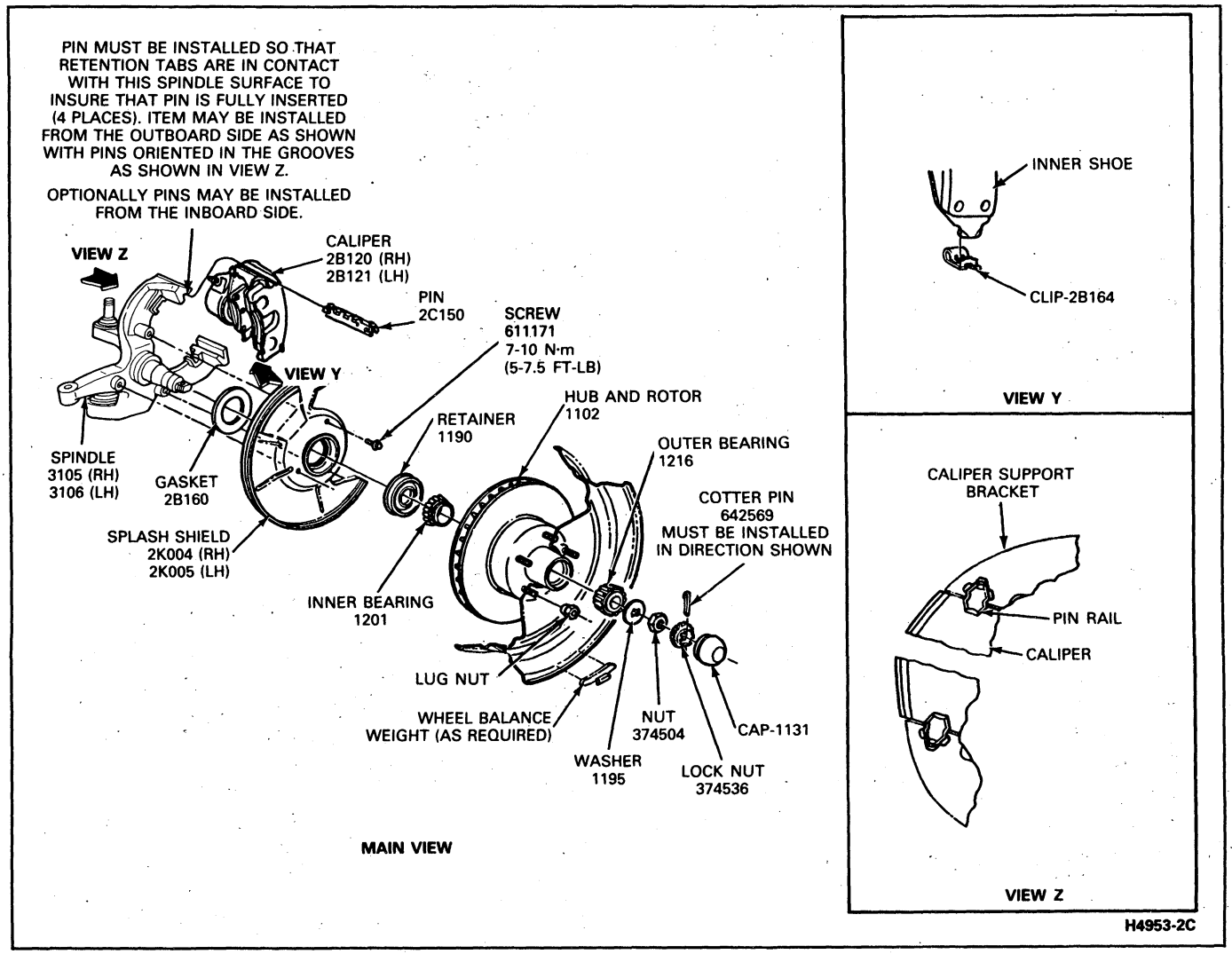


FIG. 7 Sliding Caliper Disc Brake Installation—F-150

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Rotor Thickness

Measure the thickness of the rotor to determine if it is within the specifications listed at the end of this Section. Disc brake rotors have a minimum thickness dimension (minimum wear thickness or discard thickness). This is not the refinishing dimension.

CAUTION: Never refinish a rotor to the minimum wear or discard thickness.

Refinishing

Use a disc brake lathe to refinish the disc brake rotors. (Follow manufacturer's instructions).

Replace the rotor when the overall thickness is at or below the specified minimum thickness shown on the rotor. Refer to Specifications at the end of this Section for minimum (discard) rotor thickness, maximum brake surface lateral runout, thickness variation, and surface finish.

ADJUSTMENTS

Disc Brake Shoe Adjustment

The disc brake assembly is designed so that it is inherently self-adjusting and requires no manual adjustment.

Automatic adjustment for lining wear is achieved by the piston sliding outward in the cylinder bore. The piston assumes a new position in the cylinder and maintains the correct adjustment.

Hydraulic System Bleeding

When any part of the hydraulic system has been disconnected for repair or replacement, air may get into the lines and cause spongy pedal action. This requires the bleeding of the hydraulic system after it has been properly connected to be sure all air is expelled from the brake cylinders and lines. The hydraulic system can be bled manually or with pressure bleeding equipment such as the Rotunda Brake Bleeder model 104-00064 or equivalent.

When bleeding the brake system, bleed one brake cylinder at a time, beginning at the cylinder with the longest hydraulic line first. This will be the right rear brake, then bleed the left rear brake. Next, bleed the rear Anti-Lock Brake System Valve if applicable. Then bleed the right front brake, finally the left front brake. Keep the master cylinder reservoir filled with the specified brake fluid during the bleeding operation.

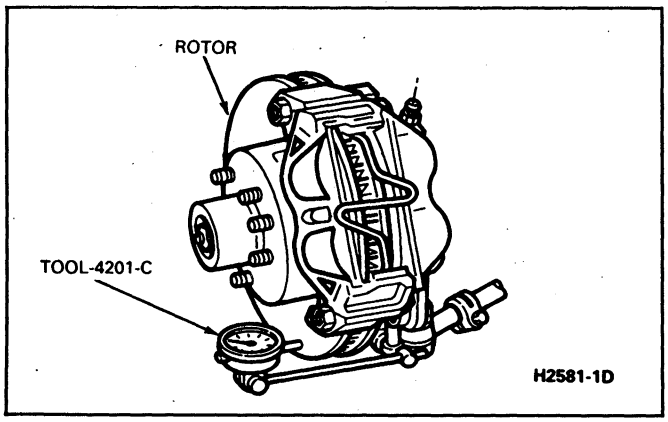


FIG. 8 Checking Rotor Runout (Typical)

Never use brake fluid which has been drained from the hydraulic system.

Manual Bleeding

Bleed the front and rear hydraulic brake systems separately. Bleed the longest line first on each system. **DO NOT allow the reservoir to run dry during the bleeding operation. Keep the master cylinder reservoirs filled with Ford Heavy Duty Brake Fluid C6AZ-19542-A AA or BA (ESA-M6C25-A) or equivalent DOT 3 fluid. Never reuse the fluid that has been drained from the hydraulic system.**

1. On the master cylinder, loosen the master cylinder-to-hydraulic line fitting.
2. Wrap a shop cloth around the tubing below the fitting to absorb escaping brake fluid.
3. Push the brake pedal down slowly to the floor of the cab. This will force air trapped in the master cylinder to escape at the fitting.
4. Hold the pedal down and tighten the fitting. Release the brake pedal. Do not release the brake pedal until the fitting is tightened or air will re-enter the master cylinder.
5. Repeat this procedure until air ceases to escape at the fitting and the brake pedal is firm.
6. Place a 3/8-inch box wrench on the bleeder fitting on the brake wheel cylinder. Attach a rubber drain tube to the bleeder fitting making sure the end of the tube fits snugly around the bleeder fitting.
7. Submerge the free end of the tube in a container partially filled with clean brake fluid. Loosen the bleeder fitting approximately three-quarters of a turn.
8. Slowly push the brake pedal all the way down. Close the bleeder fitting, and return the pedal to the fully-released position. Repeat this operation until air bubbles no longer appear at the submerged end of the bleeder tube.
9. When the fluid is completely free of air bubbles, close the bleeder fitting and remove the bleeder tube.
10. Repeat this procedure at the brake wheel cylinder on the opposite side. Refill the master cylinder reservoir after each wheel cylinder is bled. When the bleeding operation is complete, fill the master cylinder to within 3mm (1/8 in) from the top of the reservoirs.

Pressure Bleeding

Be sure the bleeder tank contains enough of the specified brake fluid to complete the bleeding operation. Charge the tank with approximately 69-206 kPa (10-30 psi). **Never exceed 345 kPa (50 psi). Never use brake fluid that has been drained from the hydraulic system. Bleed the longest lines first.**

1. Clean all dirt from the master cylinder reservoir cap.
2. Remove the master cylinder reservoir cap and fill the master cylinder reservoir with the specified brake fluid. Install the pressure bleeder adapter tool on the master cylinder, and attach the bleeder tank hose to the fitting on the adapter.

   Master cylinder pressure bleeder adapter tools are available from the manufacturers of pressure

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bleeding equipment. Follow the manufacturer's instructions when installing the adapter.

3. Place a 3/8 inch box wrench on the bleeder fitting on the right rear brake wheel cylinder. Attach a bleeder tube snugly to the bleeder fitting.
4. Open the valve on the bleeder tank and admit pressurized brake fluid to the master cylinder reservoir.
5. Submerge the free end of the tube in a container partially filled with clean brake fluid, and loosen the bleeder fitting.
6. When air bubbles no longer appear in the fluid at the submerged end of the bleeder tube, close the bleeder fitting and remove the tube.
7. Repeat Steps 3 through 6 at the opposite wheel cylinder. On front brakes, bleed the right front caliper first.
8. When the bleeding operation is completed, close the bleeder tank valve and remove the tank hose from the adapter fitting.
9. Remove the pressure bleeder adapter tool. Fill the master cylinder reservoirs with the specified brake fluid to within 3mm (1/8 in) from the top of the filler neck. Install the master cylinder cover.

SAFETY

Breathing Asbestos Dust

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

The following procedures are recommended to minimize asbestos dust exposures during brake and clutch servicing of trucks, tractors and trailers. These procedures are consistent with asbestos regulations set forth by the Occupational Safety and Health Administration (OSHA). Adherence to these procedures will eliminate exposures to asbestos during brake and clutch servicing.

An area should be designated for all brake and clutch services. Entrances to this area must be posted with the following sign:

ASBESTOS

Dust Hazard

Avoid Breathing Dust

Wear Assigned Protective Equipment

Do Not Remain in Area Unless Your Work Requires It

Breathing Asbestos Dust May Cause Asbestosis and Cancer

Only essential personnel should be present in the immediate maintenance area during brake and clutch servicing.

During brake servicing, use a toxic dust air purifying respirator of either single-use or replaceable cartridge type. It must be approved by the Mine Safety and Health Administration (MSHA) or by the National Institute of Occupational Safety and Health (NIOSH). It shall be worn during all procedures from removal of wheels to reassembly. An example of an acceptable respirator is the 3M-9910 or 9920 (or equivalent).

Wheel brake assemblies must be cleaned using a vacuum cleaner recommended for use with asbestos fibers. A vacuum for this purpose is available from the Rotunda Equipment Catalog model 091-00001. Similar vacuums are also manufactured by Nilfish and Hako ("Minuteman"). If additional cleaning is necessary, a rag soaked with water or a Rotunda Brake Washer model 065-00016 or equivalent, must be used.

Grinding or sanding on brake linings, pads, rotors or drums, shall be done only while using properly exhaust-ventilated equipment. A respirator must be worn while performing these operations.

During removal of vacuum bags, an approved respirator, as described above, shall be worn. Industrial vacuum cleaner bags containing asbestos dust, cloths used for wiping brake assemblies, and other asbestos-contaminated debris shall be sealed in plastic bags and labeled with the following warning label printed in letters of sufficient size and contrast to be readily visible and legible:

CAUTION

Contains Asbestos Fibers

Avoid Breathing Dust

Breathing Asbestos Dust May Cause Asbestosis and Cancer

All asbestos waste must be disposed in accordance with OSHA and Environmental Protection Agency (EPA) asbestos regulations. Asbestos waste must not be incinerated or disposed in community water supplies.

All floor cleaning in the asbestos servicing area and clean-up of waste from grinding or sanding must be done using an approved vacuum cleaner while wearing a proper respirator.

REMOVAL AND INSTALLATION

HD Pin Rail Slider Caliper, Brake Shoes and Linings

F-250, F-350, E-250—E-350, F-250—F-350 (4x4), F-Super Duty, Chassis Cab, Stripped Chassis and Motor Home Chassis

Replace shoe and lining assemblies as follows when the lining is worn to a minimum thickness of 0.794 mm (1/32 inch) above the backing plate. Always replace all shoes and lining assemblies on an axle. Never service one wheel only.

Removal

1. To avoid fluid overflow when the caliper pistons are pressed into the caliper cylinder bores, siphon

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or dip part of the brake fluid out of the master cylinder reservoir. Discard the removed fluid.

2. Raise the vehicle and install safety stands. Remove the front wheel and tire assembly.
3. Place an appropriate size C-clamp on the caliper (Fig. 9) and tighten the clamp to bottom the caliper pistons in the cylinder bores. Remove the clamp.

   NOTE: Do not use a screwdriver or similar tool to pry piston away from the rotor.
4. Clean excess dirt from area around pin tabs.
5. Tap upper caliper pin towards inboard side until pin tabs touch the spindle face.
6. Insert a screwdriver into the slot provided behind the pin tabs on the inboard side of the pin.
7. Use needle nose pliers to compress the outboard end of the pin while prying at the same time with the screwdriver, until the tabs slip into the spindle groove (Fig. 10).
8. Place one end of a punch (approximately 7/16 inch diameter) against the end of the caliper pin and drive the caliper pin out of the caliper slide groove.
9. Repeat removal procedure for lower pin.

NOTE: The tool shown in Fig. 11 may be fabricated to use for pin removal in place of the pliers and punch. Use the tool as follows:

- Place the notched end of the tool over the narrow end of the pin.
- The "V" notch in the tool is used to compress the pin retention tabs, while driving the pin out of the caliper slide groove.

10. Remove the caliper from the rotor. If the caliper is to be removed for service, remove the brake hose from the caliper.

    CAUTION: Do not let the caliper hang by the flexible hose. The hose could become stretched or twisted and cause premature brake failure.
11. Remove the outer and inner lining and remove the anti-rattle spring.

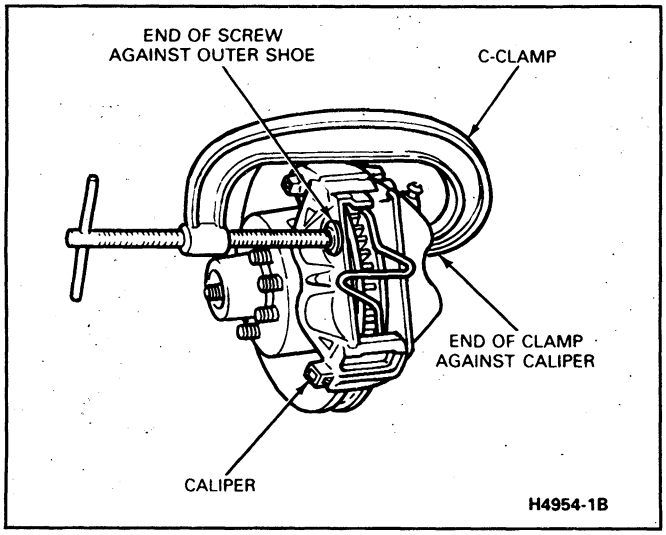


FIG. 9 Bottoming Caliper Piston

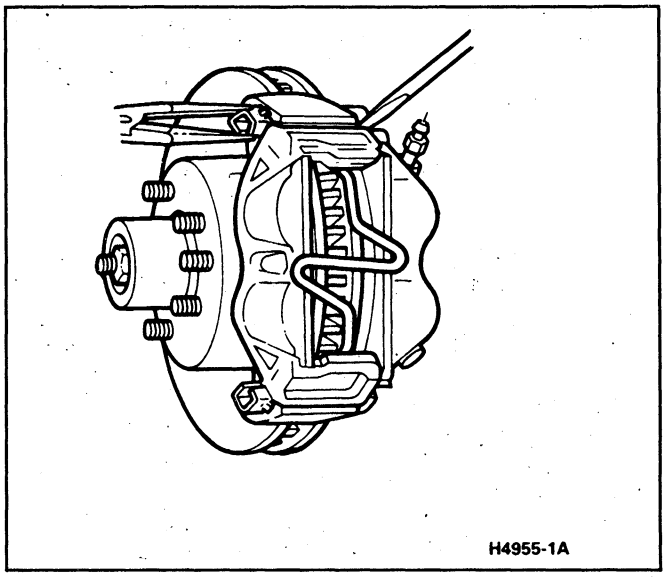


FIG. 10 Compressing Spring Tabs

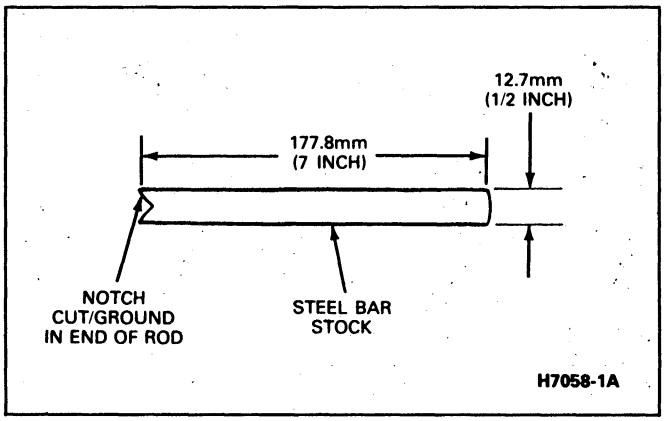


FIG. 11 Caliper Pin Removal Tool

Installation

1. Install new inner and outer shoe. Install anti-rattle spring. **Always replace all shoe and lining assemblies on an axle. Never service one wheel only.**

   NOTE: There is a raised section at one end of each shoe so that installation can be made in one direction only.
2. Install the caliper on the spindle, making sure the mounting surfaces are free of dirt and lubricate the caliper grooves with Disc Brake Caliper Grease, D7AZ-19590-A (ESA-M1C72-A) or equivalent.
3. Position pin with the pin retention tabs oriented adjacent to the spindle groove (Fig. 17).
4. Tap the pin on the outboard end with a hammer. Continue tapping the pin inward until the retention tabs on the sides of the pin contact the spindle face. Repeat procedure for the lower pin.

CAUTION: During the installation procedure do not allow the tabs of the caliper pin to be tapped too far into the spindle groove. If this happens it will be necessary to tap the other end of the caliper pin until the tabs snap into place. The tabs on each end of the caliper pin must be free to catch on the spindle flanks. See Figure 18.

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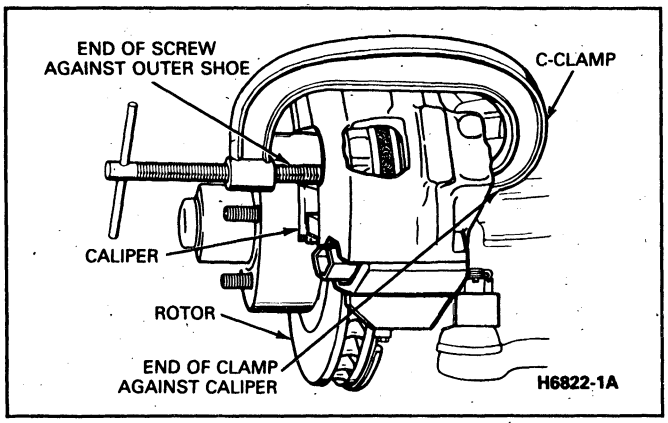


FIG. 12 Bottoming Caliper Piston (Typical)

5. If removed, install the brake hose to the caliper and bleed the brakes as described in Section 12-01, General Hydraulic Brake Service.
6. Install the wheel and tire assembly.
7. Lower the vehicle, check the brake fluid level and fill as necessary. Check brakes for proper operation.

LD Pin Rail Sliding Caliper, Brake Shoes and Linings

F-150 (4x2), E-150, Bronco, F-150 (4x4)

Removal

Replace shoe and lining assemblies as follows when the lining is worn to a minimum thickness of 1.5mm (1/16 inch) above the shoe plate. **Always replace all shoe and lining assemblies on an axle. Never service one wheel only.**

1. To avoid fluid overflow when the caliper piston is pressed into the caliper cylinder bores, siphon or dip part of the brake fluid out of the master cylinder reservoir. Discard the removed fluid.
2. Raise the vehicle and install safety stands. Remove a front wheel and tire assembly.
3. Place an eight-inch C-clamp on the caliper (Fig. 13) and tighten the clamp to bottom the caliper piston in the cylinder bore. Remove the clamp.

   NOTE: Do not use a screwdriver or similar tool to pry piston away from the rotor.
4. Clean excess dirt from area around pin tabs.
5. Tap upper caliper pin towards inboard side until pin tabs touch the spindle face.
6. Insert a screwdriver into the slot provided behind the pin tabs on the inboard side of the pin.
7. Use needle nose pliers to compress the outboard end of the pin while prying at the same time with the screwdriver, until the tabs slip into the spindle groove (Fig. 13).
8. Place one end of a punch (approximately 7/16 inch diameter) against the end of the caliper pin and drive the caliper pin out of the caliper slide groove.
9. Repeat removal procedure for lower pin.

NOTE: The tool shown in Fig. 11 may be fabricated to use for pin removal in place of the pliers and punch. Use the tool as follows:

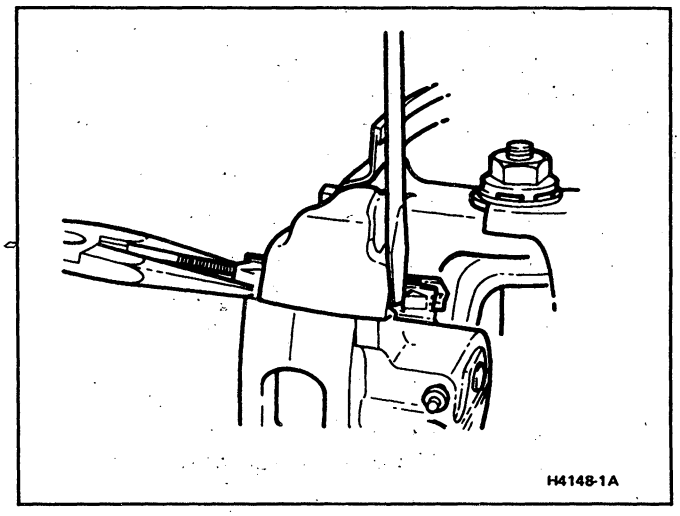


FIG. 13 Compressing Pin Tabs

- Place the notched end of the tool over the narrow end of the pin.
- The "V" notch in the tool is used to compress the pin retention tabs, while driving the pin out of the caliper slide groove.

10. Remove the caliper from the rotor. If the caliper is to be removed for service, remove the brake hose from the caliper. If the caliper is not going to be removed, wire it up to the vehicle to avoid damage to the brake hose.
11. Remove the outer lining. Remove the anti-rattle clips and remove the inner lining.

Installation

1. Place a new anti-rattle clip on the lower end of the inner shoe (Fig. 14). Be sure the tabs on the clip are positioned properly and the clip is fully seated.
2. Position the inner shoe and anti-rattle clip in the shoe abutment with the anti-rattle clip tab against the shoe abutment and the loop-type spring away from the rotor (Fig. 15). Compress the anti-rattle clip and slide the upper end of the shoe in position.
3. Install the outer shoe. Crimp or bend outer shoe tabs to prevent shoes from rattling in caliper.
4. Install the caliper on the spindle, making sure the mounting surfaces are free of dirt and lubricate the caliper grooves with Disc Brake Caliper Grease, D7AZ-19590-A (ESA-M1C72-A) or equivalent.
5. Position pin with the pin retention tabs oriented adjacent to the spindle groove Fig. 16.

   NOTE: Do not use the bolt and nut with the new pin.
6. Tap the pin on the outboard end with a hammer. Continue tapping the pin inward until the retention tabs on the sides of the pin contact the spindle face. Repeat procedure for the lower pin.

CAUTION: During the installation procedure do not allow the tabs of the caliper pin to be tapped too far into the spindle groove. If this happens it will be necessary to tap the other end of the caliper pin until the tabs snap into place. The tabs on each end of the caliper pin MUST be free to catch on the spindle flanks. See Figure 17.

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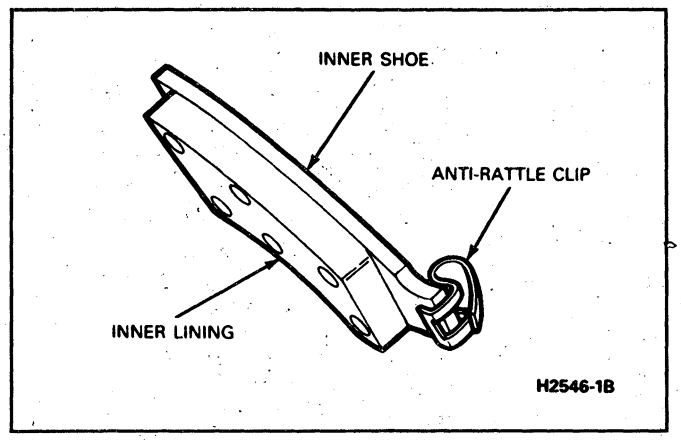


FIG. 14 Installing Anti-Rattle Clip-On Inner Shoe

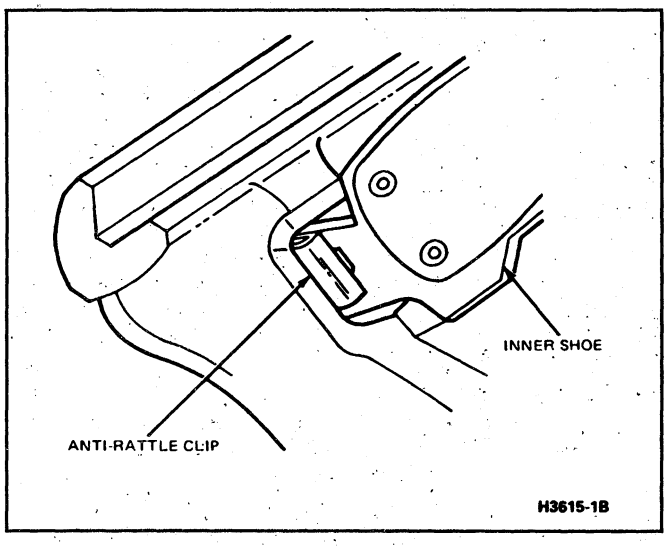


FIG. 15 Installing Inner Shoe and Anti-Rattle Clip

7. If removed, install the brake hose to the caliper and bleed the brakes as described in Section 12-01, General Hydraulic Brake Service.
8. Install the wheel and tire assembly.
9. Lower the vehicle, check the brake fluid level and fill as necessary. Check brakes for proper operation.

Disc Brake Hub and Rotor

Removal

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the caliper assembly from the rotor and hold it out of the way with wire. Refer to Caliper Removal instructions in this Section.
4. Remove the dust cap, cotter pin, nut, washer, and outer bearing, and remove the rotor from the spindle. (4x4 vehicles refer to Section 11-12, Wheels, Hubs and Bearings—Front Wheel Drive for procedures). Check the condition of the rotor as described under Disc Brake Rotor in the Disassembly and Assembly portion of this Section.
5. Remove inner bearing cone and seal. Discard the seal.

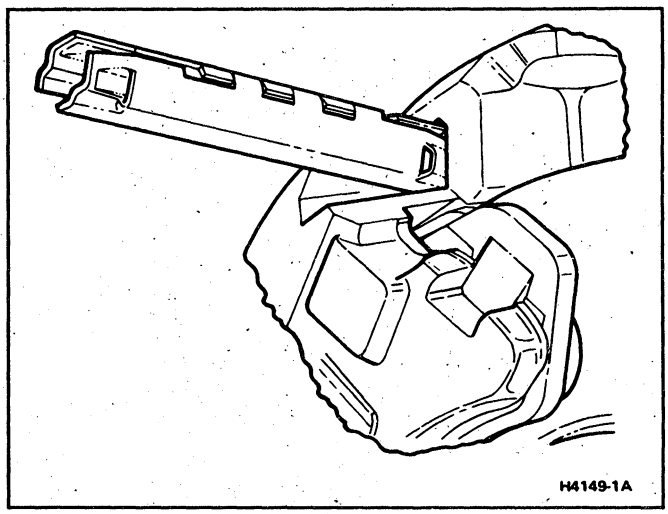


FIG. 16 Caliper Pin Installation

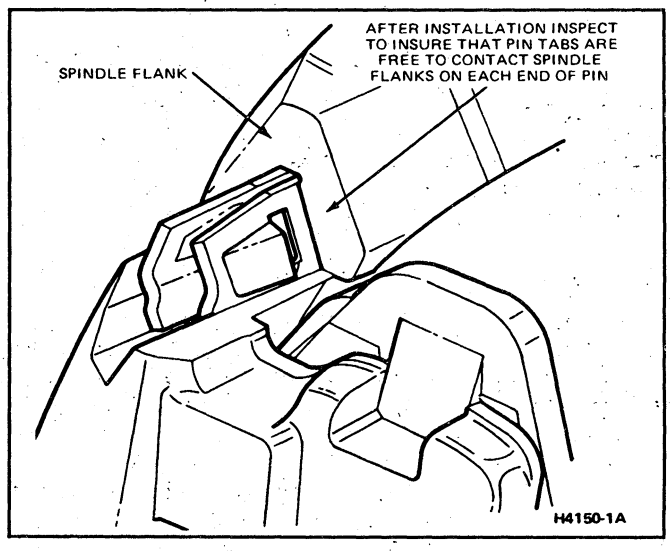


FIG. 17 Correct Caliper Pin Installation

6. On F-Super Duty the rotor can be removed from the hub by removing the ten (10) M 12 x 1.75 x 32.50mm E-18 External Torx machine screws.

Installation

1. If a new hub and rotor will be installed, remove the protective coating or any dirt or grease deposits with degreaser. On F-Super Duty series vehicles the machine screw threads must be coated with a suitable adhesive before attaching the rotor to the hub. Tighten screws to 100-120 N·m (74-89 ft-lb).
2. Pack the inner and outer bearing cone with a lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA, (ESA-M1C75-B), or equivalent.
3. Install the inner bearing cone and seal as described in Section 11-10, Wheels, Hubs, and Bearings—Front (Except Front Drive). (4x4 vehicles refer to Section 11-12, Wheels, Hubs and Bearings—Front Wheel Drive, for procedures.)
4. Install the hub and rotor on the spindle.
5. Install the outer bearing cone, washer, and nut. Adjust bearing end play and install the cotter pin and dust cap as described in Section 11-10, Wheels, Hubs and Bearings—Front (Except Front

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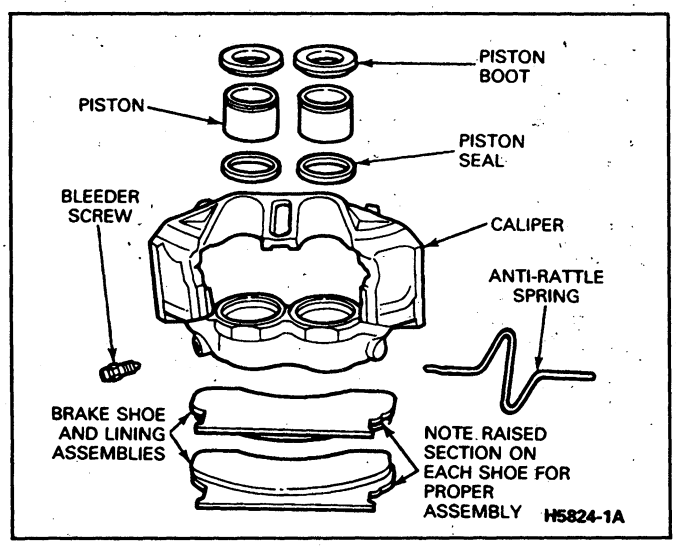


FIG. 18 Front Disc Brake Caliper Disassembled—HD Rail Slider

Drive). (4x4 vehicles refer to Section 11-12, Wheels, Hubs, and Bearings—Front Wheel Drive, for procedures).

6. Install the caliper as described in this Section.
7. Install the wheel and tire assembly.
8. Lower the vehicle.

Hydraulic Line Repair

Steel tubing is used in the hydraulic lines between the master cylinder and the front brake tube connector, and between the rear brake tube connector and the rear brake cylinders. Flexible hoses connect the brake tube to the front brake cylinders and to the rear brake tube connector.

When replacing hydraulic brake tubing, hoses, or connectors, tighten all connections securely. After replacement, bleed the brake system at the wheel cylinders and at the booster (if equipped).

Brake Tube

If a section of the brake tube is damaged, replace it with tubing of the same type, size, shape, and length. **Do not use copper tubing in the hydraulic system. Be careful not to kink or crack the tubing when bending it to fit the frame or rear axle.**

Double flare the brake tubing (Section 12-01, General Hydraulic Brake Service) to provide good leak-proof connections. Always clean the inside of a new brake tube with clean isopropyl alcohol.

Brake Hose

Replace a flexible brake hose if it shows signs of softening, cracking, or other damage.

When installing a new brake hose, position the hose to avoid contact with other vehicle parts. Whenever a brake hose is disconnected from a wheel cylinder or brake caliper, install a **new copper washer connecting the hose.**

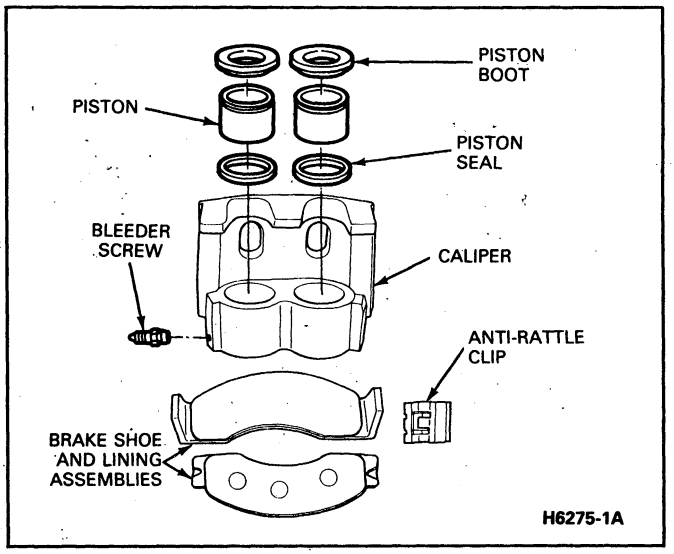


FIG. 19 Disc Brake Caliper Front and Rear—F-Super Duty

DISASSEMBLY AND ASSEMBLY

Disc Brake Caliper—HD Rail Sliding Caliper

Disassembly

Refer to Fig. 18.

1. Disconnect the flexible brake hose and plug the end to prevent brake fluid leakage. Remove the caliper assembly.
2. Remove the brake shoe and lining assemblies and anti-rattle spring.
3. Drain the fluid from the cylinders.
4. Secure the caliper assembly in a vise.
5. Place a block of wood between the caliper bridge and the cylinders, and apply low pressure air to the brake hose inlet. The pistons will be forced out to the wood block. Refer to Fig. 19.
6. Remove the wood block, and remove the pistons.
7. Remove and discard the piston seals and boots.
8. If the caliper assembly is leaking, replace the piston assemblies. If the cylinder bores are scored, corroded or excessively worn, replace the caliper. Do not hone the cylinder bores. Piston assemblies are not available for oversize bores.

Assembly

Never re-use piston seals and dust boots. Install a new set each time the caliper is assembled.

1. Lubricate new piston seals with clean brake fluid C6AZ-19542-AA or BA (ESA-M6C25-A) or equivalent and install them in the seal grooves in the cylinder bores.
2. Apply a film of clean brake fluid to the cylinder bores.
3. Lubricate the retaining lips of the dust boots with clean brake fluid and install them in the boot retaining grooves in the cylinder bores.
4. Apply a film of clean brake fluid to the pistons.
5. Insert the pistons into the dust boots and start them into the cylinders by hand until they are

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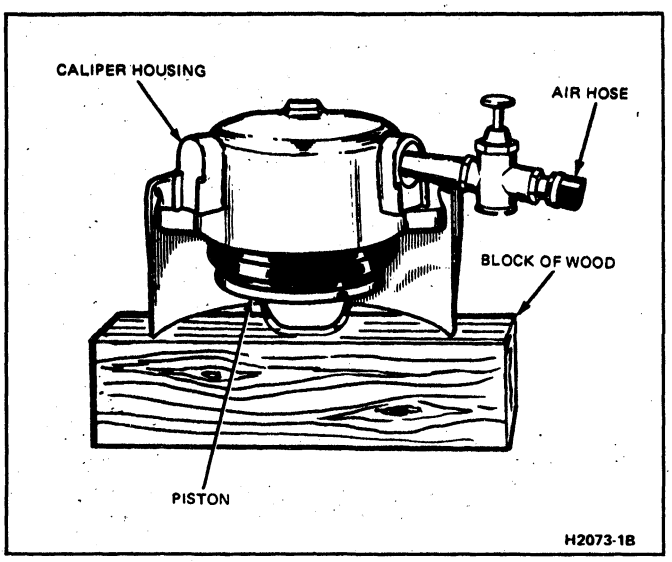


FIG. 20 Removing Caliper Piston

beyond the piston seals. **Be careful not to damage or dislodge the piston seal.**

6. Place a wood block over one piston and press the piston into the cylinder being careful not to cock the piston in the cylinder. Install the second piston in the same manner. Make certain that boots are correctly seated.
7. Install the shoe and lining assemblies and anti-rattle spring in the caliper assembly. Place the caliper assembly on the support and install the caliper pins, as outlined in this Section.
8. Install the flexible brake hose with new copper washers and tighten to specification listed at the end of this Section.
9. Bleed the brake system. **Do not move the vehicle until a firm brake pedal is obtained.**

Disc Brake Caliper—Sliding Caliper—LD

NOTE: Do not use a screwdriver or any similar tool to pry piston into or out of the bore to prevent chipping or scuffing damage to the phenolic piston.

Disassembly

Refer to Fig. 21.

1. Remove the caliper assembly from the vehicle as outlined in Caliper Removal. Remove outer brake shoe to avoid damage to lining material. Substitute shoe with a piece of wood of similar size and shape, or use a worn out shoe and lining assembly. Place a cloth over the piston before applying air pressure to prevent damage to the piston.

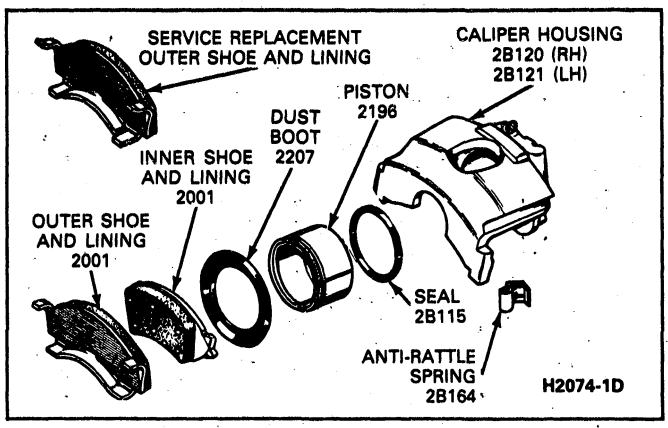


FIG. 21 Disc Brake Caliper—Disassembled—LD Sliding Caliper

2. Apply air pressure to the fluid port in the caliper with a rubber-tipped nozzle TOOL 7000-DD or equivalent, as shown in Fig. 20 to remove the piston. If the piston is seized and cannot be forced from the caliper, tap lightly around the piston while applying air pressure. **Use care because the piston can develop considerable force from pressure build-up.**
3. Remove the dust boot from the caliper assembly.
4. Remove the rubber piston seal from the cylinder, and discard it.

NOTE: Do not remove the steel ring from the piston.

Cleaning and Inspection

Clean all metal parts with isopropyl alcohol. Then, clean out and dry the grooves and passageways with compressed air. Make sure that caliper bore and component parts are thoroughly clean.

Check the cylinder bore and piston for damage or excessive wear.

Assembly

1. Apply a film of clean brake fluid to the new caliper piston seal, and install it in the cylinder bore. Be sure the seal does not become twisted but is firmly seated in the groove.
2. Install a new dust boot by setting the flange squarely in the outer groove of the caliper bore.
3. Coat the piston with brake fluid, and install the piston in the cylinder bore. Spread the dust boot over the piston as it is installed. Seat the dust boot in the piston groove, behind the pressed on steel ring.
4. Install the caliper over the rotor as outlined.

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SPECIFICATIONS

TORQUE LIMITS

Description	N-m	(ft-lbs)
Brake Hose to Caliper Attaching Bolt	24-33	17-25

TORQUE LIMITS — HYDRAULIC NUTS (FT-LBS)

Thread Size	N-m	(ft-lbs)①
3/8-24	14-20	10-15
7/16-24	14-20	10-15
1/2-20	14-23	10-17
9/16-18	14-23	10-17

①All hydraulic line connections (nuts) must be tightened to the specified value and free of fluid leakage.

ROTOR REPAIR DIMENSIONS

Vehicle	Minimum Rotor Thickness (Discard Thickness)		Rotor Thickness Maximum Variation		Brake Surface Lateral Runout (Maximum)		Rotor Surface Finish
	MM	Inch	MM	Inch	MM	Inch	Micro-Inches
E-150, F-150 (4x2)	28.50	1.12	0.013	0.0005	0.08	0.003	
F-150, Bronco (4x4) (Integral)	28.50	1.12	0.013	0.0005	0.08	0.003	
F-150, Bronco (4x4) (2-Piece)	28.50	1.12	0.018	0.0007	0.13	0.005	15
E-250-350, F-250-350 (4x2) SRW (Integral)	30.00	1.18	0.018	0.0007	0.08	0.003	to
F-350, E-350 (4x2) DRW (2-Piece)	30.00	1.18	0.025	0.0010	0.13	0.005	80
F-250-350, (4x4) SRW	30.00	1.18	0.025	0.0010	0.13	0.005	
F-350 (4x4) DRW	30.00	1.18	0.025	0.0010	0.13	0.005	
F-Super Duty Chassis Cab, Stripped Chassis, Motor Home Chassis DRW	36.3	1.43	0.025	0.0010	0.20	0.008	15-80

CH2487-2M

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer – 2-1/2 lb.	Universal
D79P-100-A	Impact Slide Hammer – 5 lb.	Universal
T59L-100-B	Impact Slide Hammer – 2-1/2 lb.	Universal
T71P-1102-A	Disc Rotor Surface Gauge	Universal
T73L-2196-A	Disc Brake Piston Remover	Use with Slide Hammer
D79L-2196-A	Disc Brake Pad Spreader	Universal
TOOL-4201-C	Dial Indicator with Bracketry	Universal

CH2701-2F

ROTUNDA EQUIPMENT

Model Number	Description
104-00064	Brake Bleeder
091-00001	Asbestos Vacuum
065-00016	Brake Parts Washer

CH3539-1E

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SECTION 12-30 Brake Pedal, Master Cylinder and Valves

SUBJECT	PAGE
ADJUSTMENTS	12-30-3
DESCRIPTION AND OPERATION	
Brake Pedal	12-30-1
Height Sensing Brake Proportioning Valve	12-30-1
Master Cylinder	12-30-1
Plastic Reservoir with Fluid Level Indicator	12-30-1
Proportioning Valve	12-30-1
DIAGNOSIS AND TESTING	12-30-3
DISASSEMBLY AND ASSEMBLY	
Master Cylinder	12-30-6
Assembly	12-30-7
Bleeding the Master Cylinder	12-30-8
Disassembly	12-30-7
REMOVAL AND INSTALLATION	
Brake Pedal	12-30-5
E-150—E-350	12-30-5
Brake Pedal Assembly	12-30-4
F-150—F-350, Bronco and F-Super Duty	12-30-4
Height Sensing Brake Proportioning Valve	12-30-5
Master Cylinder	12-30-3
Master Cylinder Reservoir	12-30-6
SPECIFICATIONS	12-30-11
VEHICLE APPLICATION	12-30-1

VEHICLE APPLICATION

E-150 through E-350, F-150 through F-350, Bronco and F-Super Duty Vehicles.

DESCRIPTION AND OPERATION

Master Cylinder

The dual master cylinder contains a plastic "see-thru" fluid reservoir with a Fluid Level Indicator (FLI) and primary and secondary hydraulic pistons and an integral proportioning valve.

The dual master cylinder performs in the following manner:

REAR WHEEL BRAKES —the rear wheel brakes are connected to the secondary outlet port and are actuated by the secondary piston assembly.

FRONT WHEEL BRAKES —the front wheel brakes are connected to the primary outlet port (farthest from the dash panel) and are actuated by the primary piston assembly.

Both primary and secondary pistons function together.

Refer to Fig. 2 for an illustration of the Econoline master cylinder operation.

On all vehicles (except F-Super Duty) the master cylinder is assisted by a vacuum booster. On F-Super Duty a Bendix Hydroboost is used. Information about the vacuum booster is given in Sections 12-50, Vacuum Brake Booster—Single Diaphragm—Dash Mounted (Bendix) and 12-52 Vacuum Brake Booster—Tandem Diaphragm—Dash Mounted (Bendix). Information on the Bendix Hydroboost is given in Section 12-57.

Brake Pedal

The brake pedal transfers and intensifies the force applied by the operator to the front discs and rear drums to stop or slow down the vehicle. A brake stoplamp switch is mounted on the pedal and whenever the pedal is depressed the rear brake lamps are illuminated.

Plastic Reservoir with Fluid Level Indicator

Refer to Fig. 4.

The fluid level indicator is an integral part of the fluid reservoir. It is serviced as a part of the plastic reservoir assembly. It consists of a float containing a magnet and a reed switch. When the fluid in the reservoir gets to a predetermined level, the magnet actuates the reed switch, causing the warning lamp to light. Loss of fluid from either the primary (front) or secondary (rear) system will cause this system to actuate.

If the fluid level indicator is deemed to be inoperative, the plastic reservoir must be replaced.

Proportioning Valve

The proportion valve is integral to the master cylinder on F-Series, Bronco, and E-Series vehicles (Fig. 4). The valve functions to recirculate rear brake system hydraulic pressure. A plug and tube seat is pressed into the outlet port of the master cylinder. A hole through the center of the plug and tube seat directs the hydraulic fluid down the valve to the rear brake system outlet port. In case of the front brake system malfunction, the proportioning valve with a bypass feature allows full hydraulic pressure to the rear brake system. Refer to Fig. 5.

Height Sensing Brake Proportioning Valve

The Height Sensing Brake Proportioning Valve is used on all E-250—E-350 and F-Super Duty vehicles. The height sensing valve regulates rear brake hydraulic pressure when the vehicle is in the lightly loaded condition and allows full braking pressure to the rear brakes when the vehicle is carrying a full load (Fig. 6).

The valve is located on the number five crossmember (Fig. 15) and is activated through a linkage system that is connected to the rear axle housing cover. Movement

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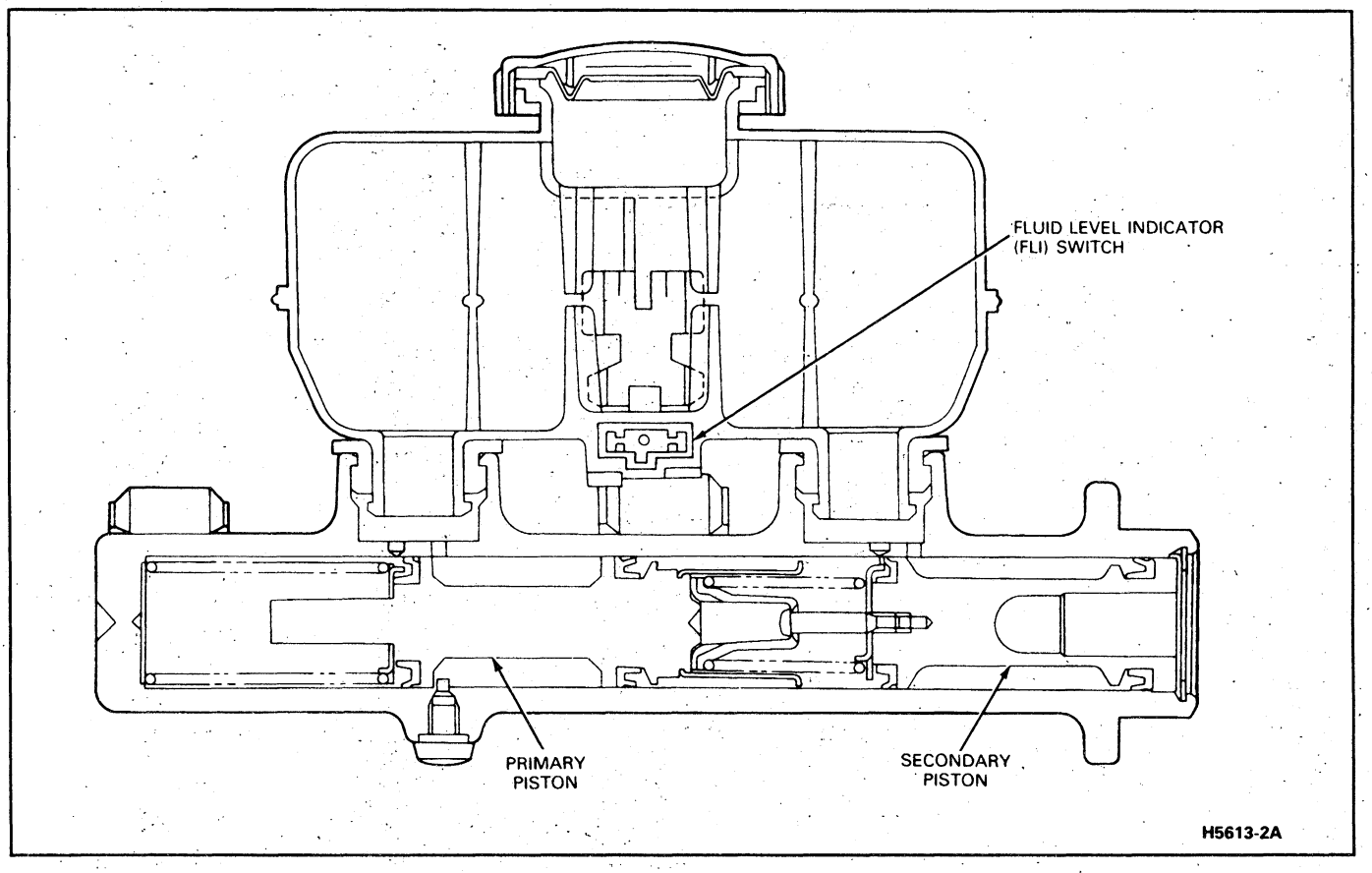


FIG. 1 Master Cylinder—Cutaway View

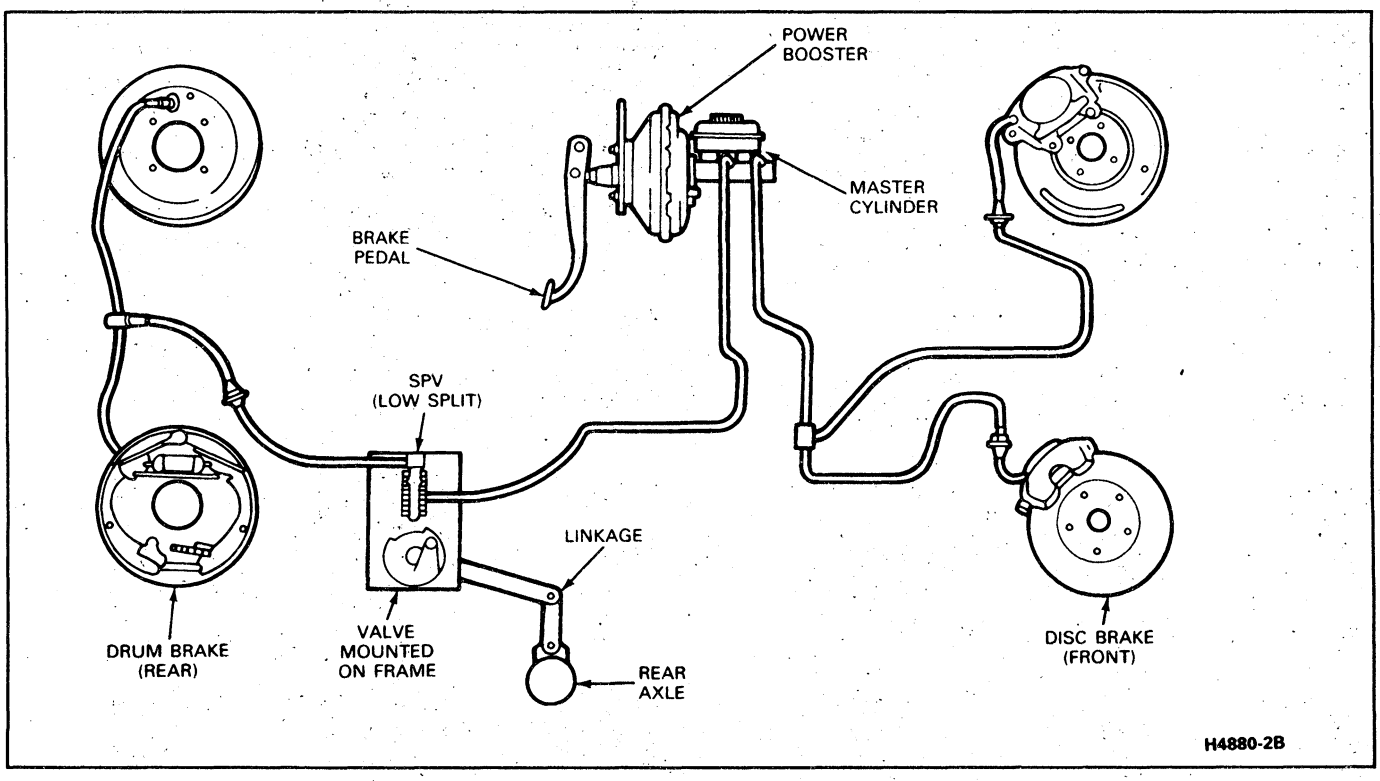


FIG. 2 Master Cylinder Operation Econoline 250—350

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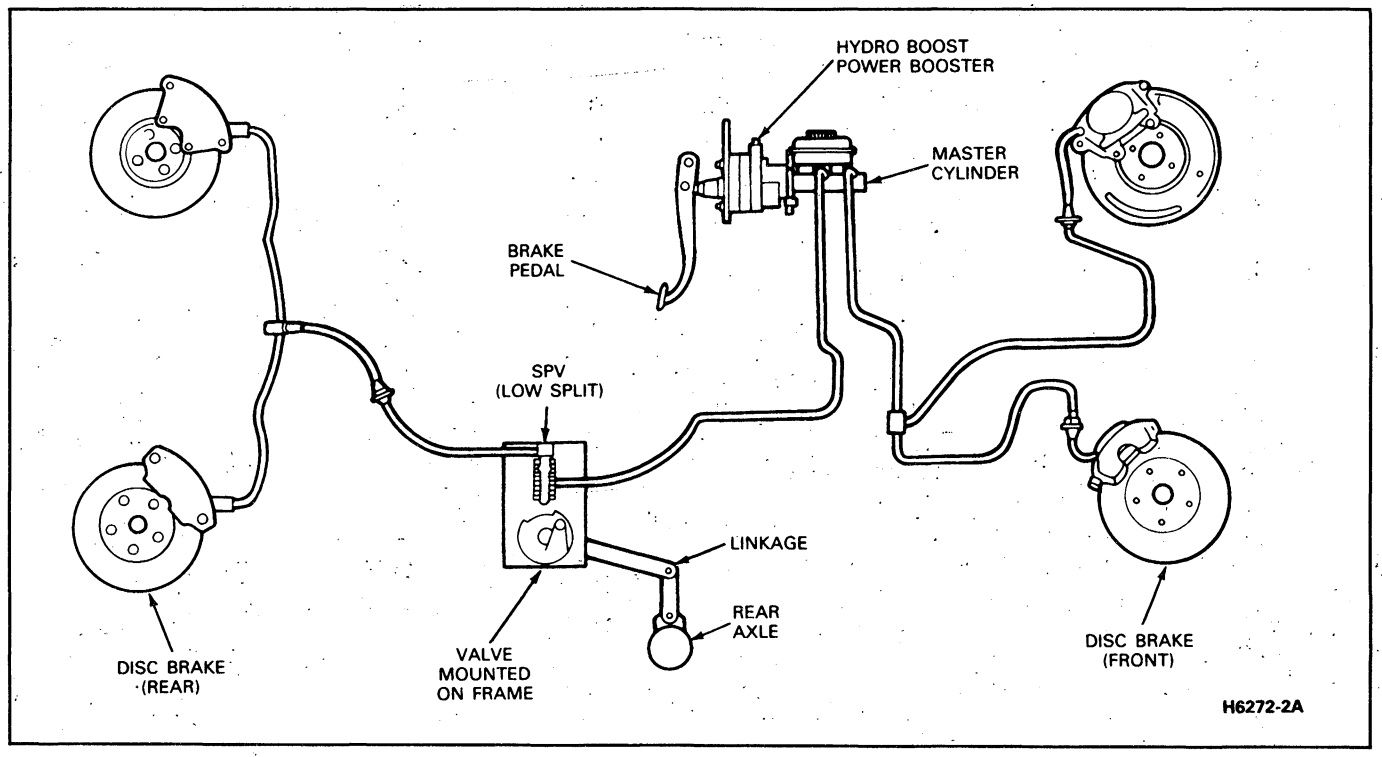


FIG. 3 Master Cylinder Operation F-Super Duty

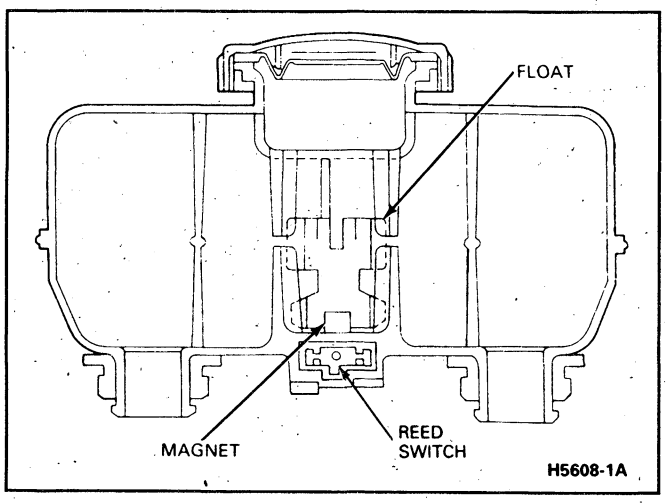


FIG. 4 Plastic Reservoir with Fluid Level Indicator

of the lever from vehicle loading will rotate the valve cam allowing the plunger to shift position. As vehicle load increases the plunger shifts farther and allows more pressure to the rear brakes.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake System.

ADJUSTMENTS

Refer to Section 12-01, General Hydraulic Brake Service, for master cylinder and brake system bleeding procedures.

REMOVAL AND INSTALLATION

Master Cylinder

Refer to Figs. 7 and 8.

Removal

1. With the engine turned off, push the brake pedal down to expel vacuum from the brake booster system. Disconnect fluid level indicator switch connector from the master cylinder.
2. Disconnect the hydraulic lines from the brake master cylinder.
3. Remove the wrap around clip and attaching nut from the booster master cylinder mounting stud.
4. Remove the brake booster - to - master cylinder retaining nuts. Remove the master cylinder from the brake booster.

Installation

1. Before installing the master cylinder, check the distance from the outer end of the booster assembly push rod, to the front face of the brake booster assembly. Turn the push rod adjusting screw in or out as required to obtain the specified length (Fig. 9).
2. Position the master cylinder assembly over the booster push rod and onto the two studs on the booster assembly. Install the attaching nuts and tighten to 24-34 N·m (18-25 ft-lbs).
3. Loosely connect the hydraulic brake system lines to the master cylinder.
4. Position the wrap around clip over the mounting stud. Install and tighten the attaching nut.
5. Tighten the attaching nut to 24-34 N·m (18-25 ft-lb).

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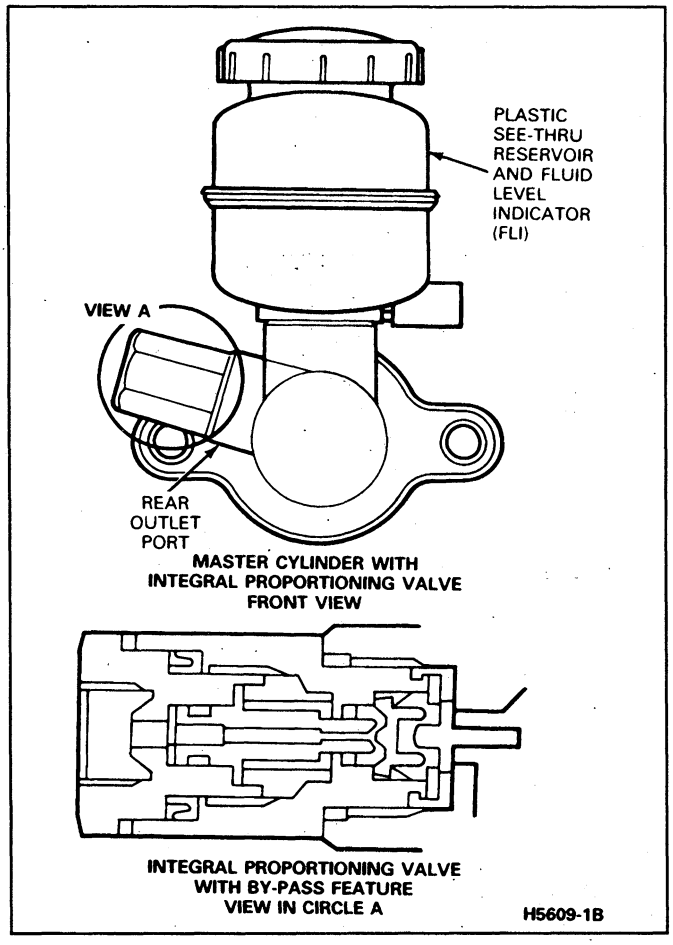


FIG. 5 Master Cylinder Assembly and Integral Proportioning Valve

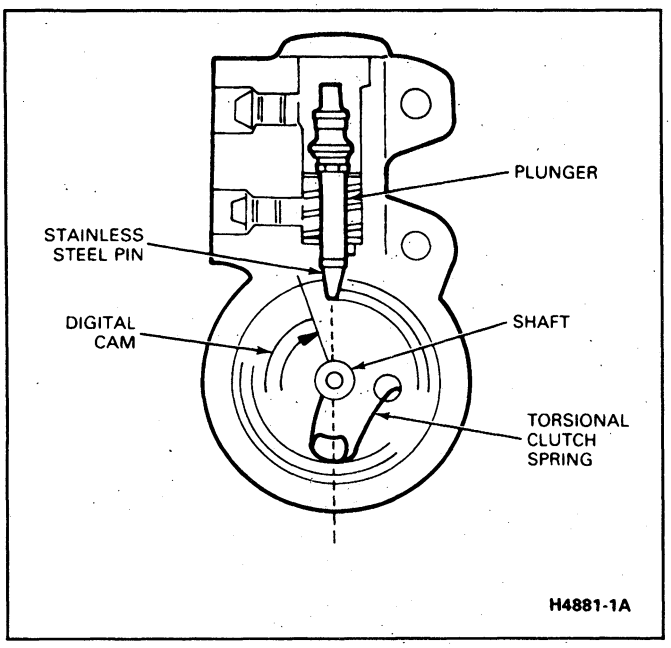


FIG. 6 Height Sensing Brake Proportioning Valve—Cutaway View

6. Connect fluid level indicator switch.

7. Bleed the master cylinder as described in Section 12-01, General Hydraulic Brake Service. Fill the plastic reservoir of the master cylinder with Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or an equivalent to the fluid fill line. Install gasket and bleed the hydraulic brake system as described in Section 12-01.

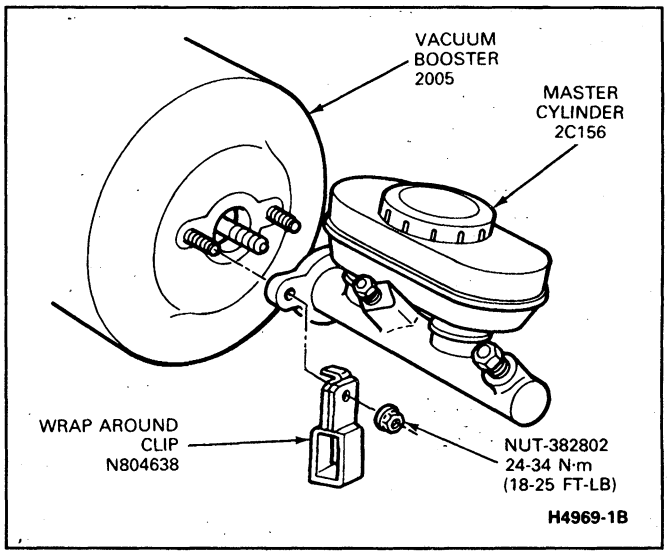


FIG. 7 Master Cylinder Installation—F-150—F-350 and Bronco

Brake Pedal Assembly

F-150—F-350, Bronco and F-Super Duty

Refer to Figs. 10 and 11.

Removal

1. Working inside the cab, below the instrument panel, disconnect the wires from the stop lamp switch. Remove the cotter pin and spacer connecting the brake pedal assembly, stop lamp switch assembly and master cylinder push rod together. Remove the stop lamp switch and master cylinder push rod from the pin on the brake pedal.
2. On vehicles equipped with manual transmissions, disconnect the clutch pedal retracting spring. Remove the nut (by the brake pedal) on the clutch rod lever and remove the lever, washer spring, and bushing. Push the clutch pedal assembly to the side enough for the brake pedal assembly to come off the shaft. Take off the brake pedal bushings.
3. On vehicles equipped with automatic transmission, remove one spring retainer and bushing from the brake pedal shaft. From the other end, pull out the shaft and remove the brake pedal assembly. Remove the bushings and washer spring from the brake pedal.
4. Remove the stop lamp switch from the bracket on the brake pedal.
5. Remove the pedal pad, if required.

Installation

1. Install the pedal pad on the brake pedal assembly, if required.
2. Install the stop lamp switch on the brake pedal bracket.
3. Place bushings and washer spring in position on the brake pedal assembly.

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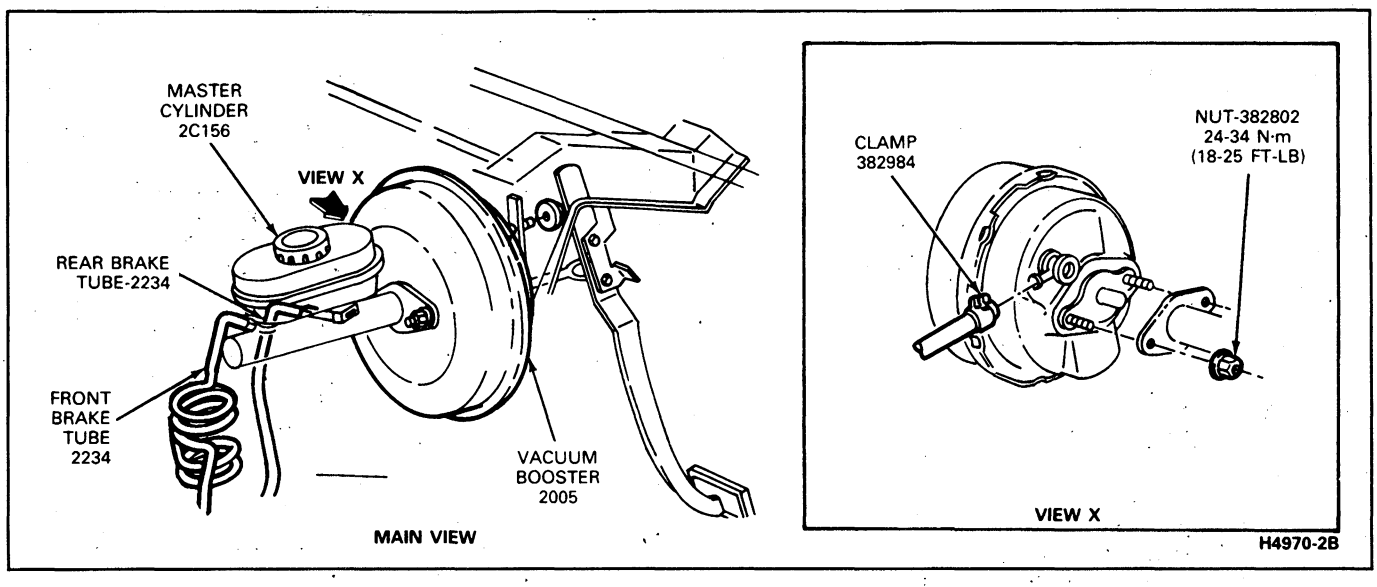


FIG. 8 Master Cylinder Installation—E-150—E-350

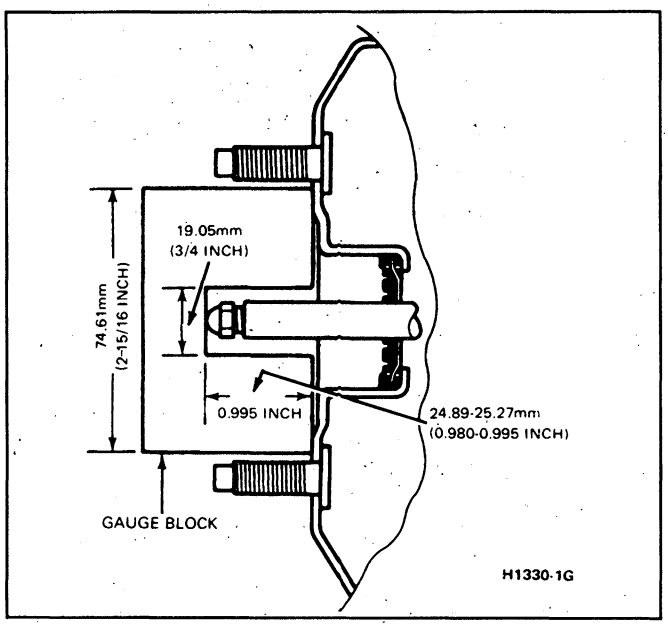


FIG. 9 Bendix Booster Push Rod Gauge Dimensions and Adjustment

4. On vehicles equipped with manual transmissions, move the pedal assembly into the bracket. Slide the clutch pedal assembly so the clutch shaft goes through the hub of the brake pedal assembly. Install the bushing and clutch rod and lever onto the clutch shaft. Position the nut holding the clutch lever to clutch shaft and tighten. Connect the clutch pedal retracting spring.

5. On vehicles equipped with automatic transmission, move the brake pedal assembly into the bracket. Slide the brake pedal shaft through the bracket and hub on the brake pedal. Install bushings and spring retainers on the shaft.

6. Place the bushing spacer stop lamp switch assembly and master cylinder push rod onto the pin on the brake pedal. Install the spacer and cotter pin.

7. Connect wires to stop lamp switch. Check unit for correct operation.

Brake Pedal

E-150—E-350

Refer to Figs. 12 and 13.

Removal

1. Remove the retainer to disconnect the stoplamp switch assembly and master cylinder push rod from the brake pedal.
2. Remove the cotter pin and nut holding the pedal shaft to the bracket.
3. Remove the pedal from the bracket by removing the nut.
4. Remove the bushings from the pedal shaft.

Installation

1. Install the pedal assemblies through the brackets. Install the washer, nut and cotter pin.
2. Position the brake master cylinder push rod on the pedal assembly. Install the stop lamp switch and retainer.

Height Sensing Brake Proportioning Valve

E-250—E-350 and F-Super Duty

Refer to Fig. 14.

NOTE: The height sensing valve is not to be disassembled or repaired, it is serviced as a complete assembly only.

Removal

1. Raise the vehicle on a hoist so that the rear suspension hangs in the fully extended position.
2. Remove the nut holding the linkage arm to the height sensing valve and disconnect the linkage arm.
3. Remove the flow bolt holding the flexible brake hose to the valve.
4. Disconnect the brake line from the valve.

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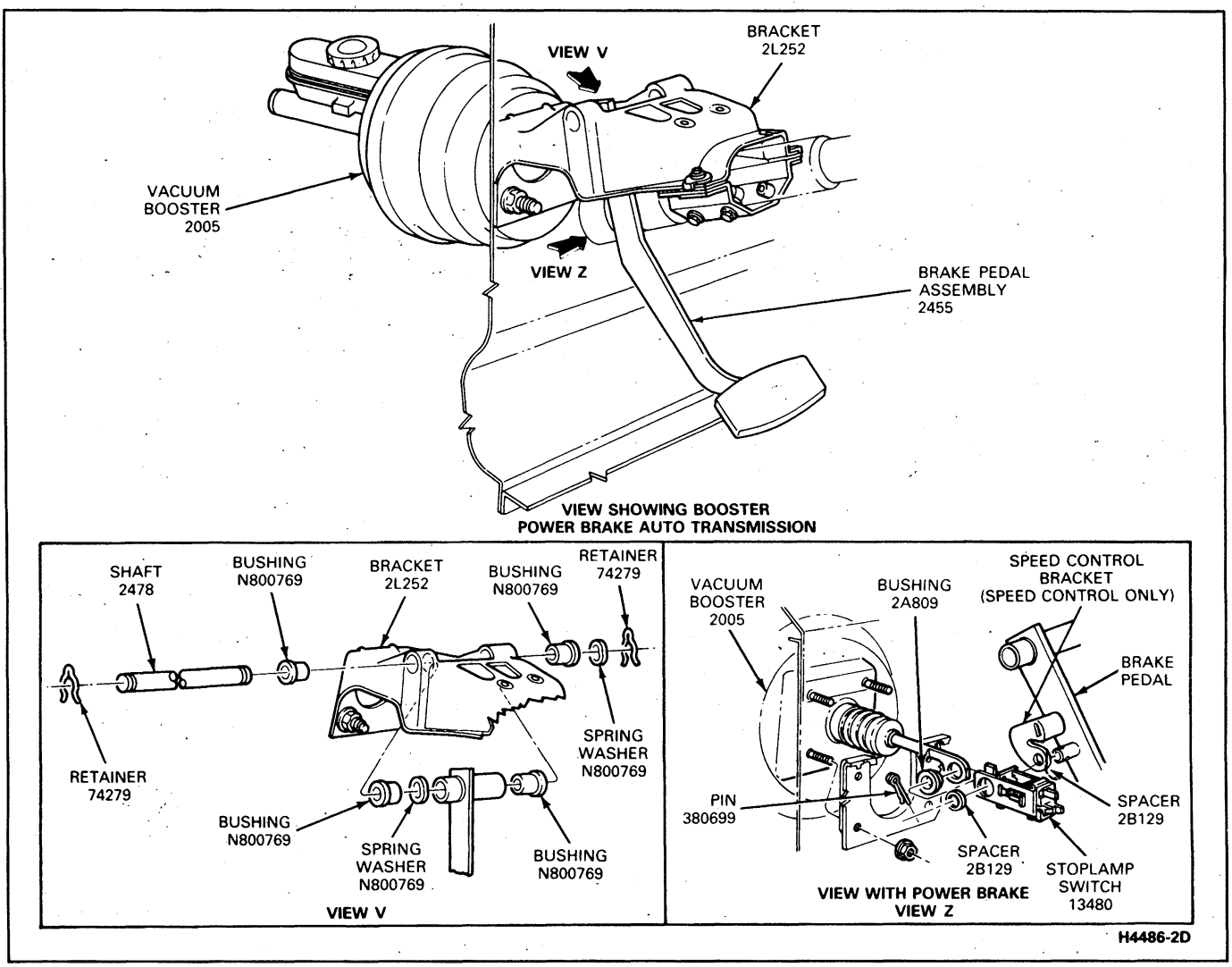


FIG. 10 Brake Pedal Installation—F-150—F-350 and Bronco with Automatic Transmission

5. Remove the two bolts securing the height sensing valve to its mounting bracket, and remove the valve.

Installation

1. Place the height sensing valve on its mounting bracket. Install the two mounting bolts and tighten to 17-24 N·m (12-18 ft-lbs).
2. Install the flexible brake hose using new copper gaskets. Tighten the flow bolt to 37-46 N·m (28-34 ft-lbs).
3. Install the brake line to the lower port on the valve and tighten securely.
4. Position the linkage arm on the height sensing valve and tighten the retaining nut to 11-14 N·m (8-10 ft-lbs).
5. Bleed the brakes as described in Section 12-01, General Hydraulic Brake Service. Check for proper brake operation.

Master Cylinder Reservoir

Refer to Fig. 15.

Removal

1. Disconnect the brake warning lamp indicator wire from the plastic reservoir fluid level indicator socket. Drain the brake fluid from the master cylinder assembly.
2. Using a large screwdriver, pry between the reservoir and the master cylinder body (Fig. 16) and remove the reservoir.

Installation

1. Lubricate the two grommets included in Service Kit 2K478 with Heavy Duty Brake Fluid, C6AZ-19542-A or B (ESA-M6C25-A) or an equivalent DOT 3 fluid. Insert the grommets into the master cylinder body.

NOTE: Whenever the master cylinder plastic reservoir is replaced, the grommets must also be replaced.

2. Press the plastic reservoir into the grommets with the fluid level indicator socket facing outboard. The reservoir should snap in place, indicating that it is secure.
3. Connect the brake warning lamp indicator wire to the fluid level indicator socket.

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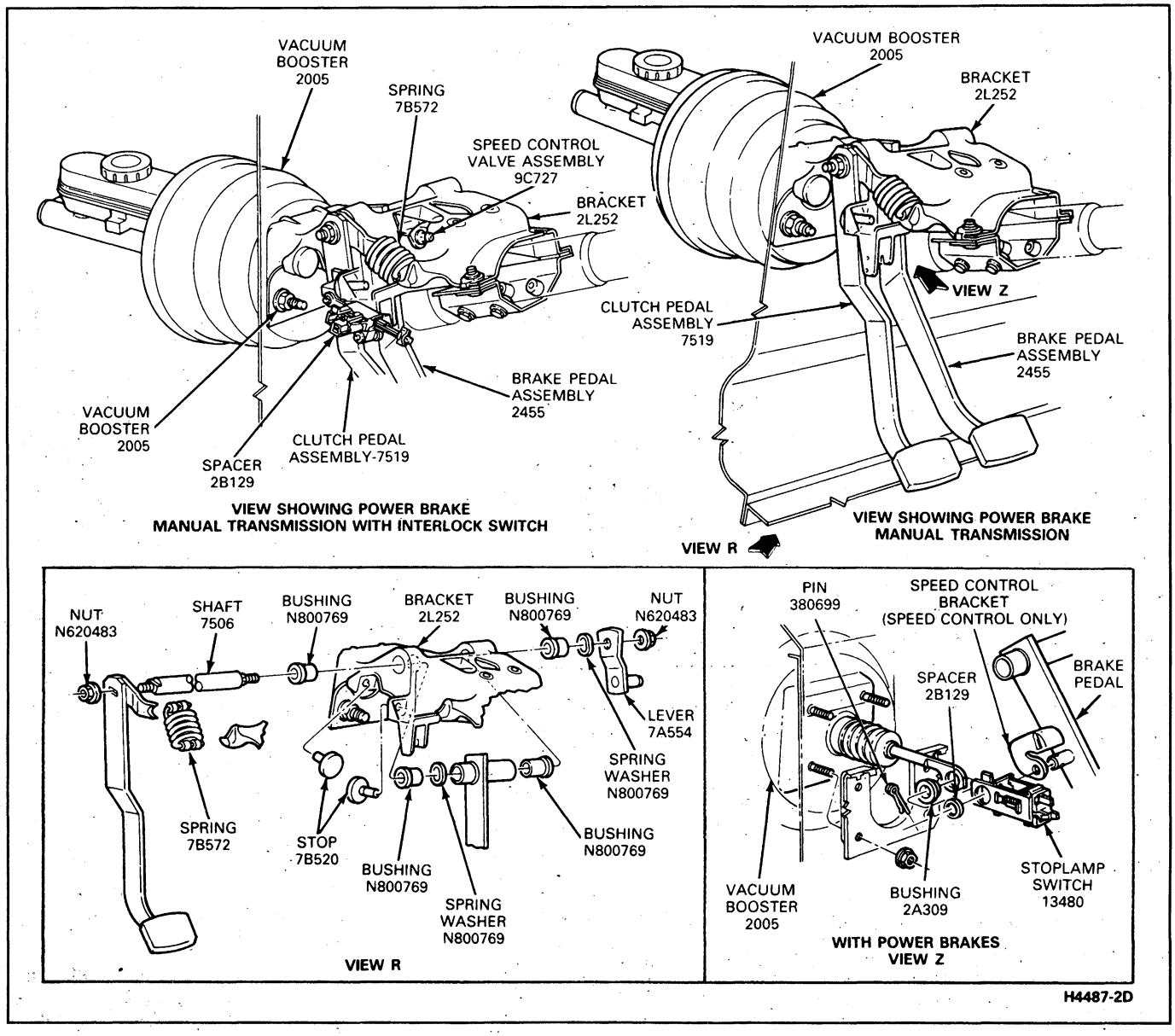


FIG. 11 Brake Pedal Installation—F-150—F-350 and Bronco with Manual Transmission

4. Fill the reservoir with Heavy Duty Brake Fluid, C6AZ-19542-A or -B (ESA-M6C25-A) or an equivalent DOT 3 brake fluid. Bleed the system as outlined in this Section.

DISASSEMBLY AND ASSEMBLY

Master Cylinder

Refer to Fig. 17.

Remove the master cylinder from the vehicle for overhaul.

Disassembly

1. Clean the outside of the master cylinder and remove the plastic cap and gasket. Drain and discard any brake fluid that remains in the cylinder.
2. Remove the proportioning valve from the master cylinder.
3. Remove stop-bolt from the bottom of the master cylinder assembly.
4. Depress the secondary piston and remove snap ring (Fig. 18) from retaining groove at the rear of the master cylinder bore.
5. Remove secondary piston assembly from the master cylinder bore and inspect for seal damage or twisting. Record condition of piston assembly on repair order and discard assembly.
6. Remove the primary piston assembly by directing compressed air into the outlet port at the blind end of the bore while plugging the other outlet port. Inspect for seal damage or twisting. Record condition of piston assembly on repair order and discard assembly.
7. Inspect the master cylinder bore for signs of etching, pitting, scoring or other damage.
   a. If bore is damaged, discard and replace with new master cylinder assembly. **Do not attempt to hone bore.**

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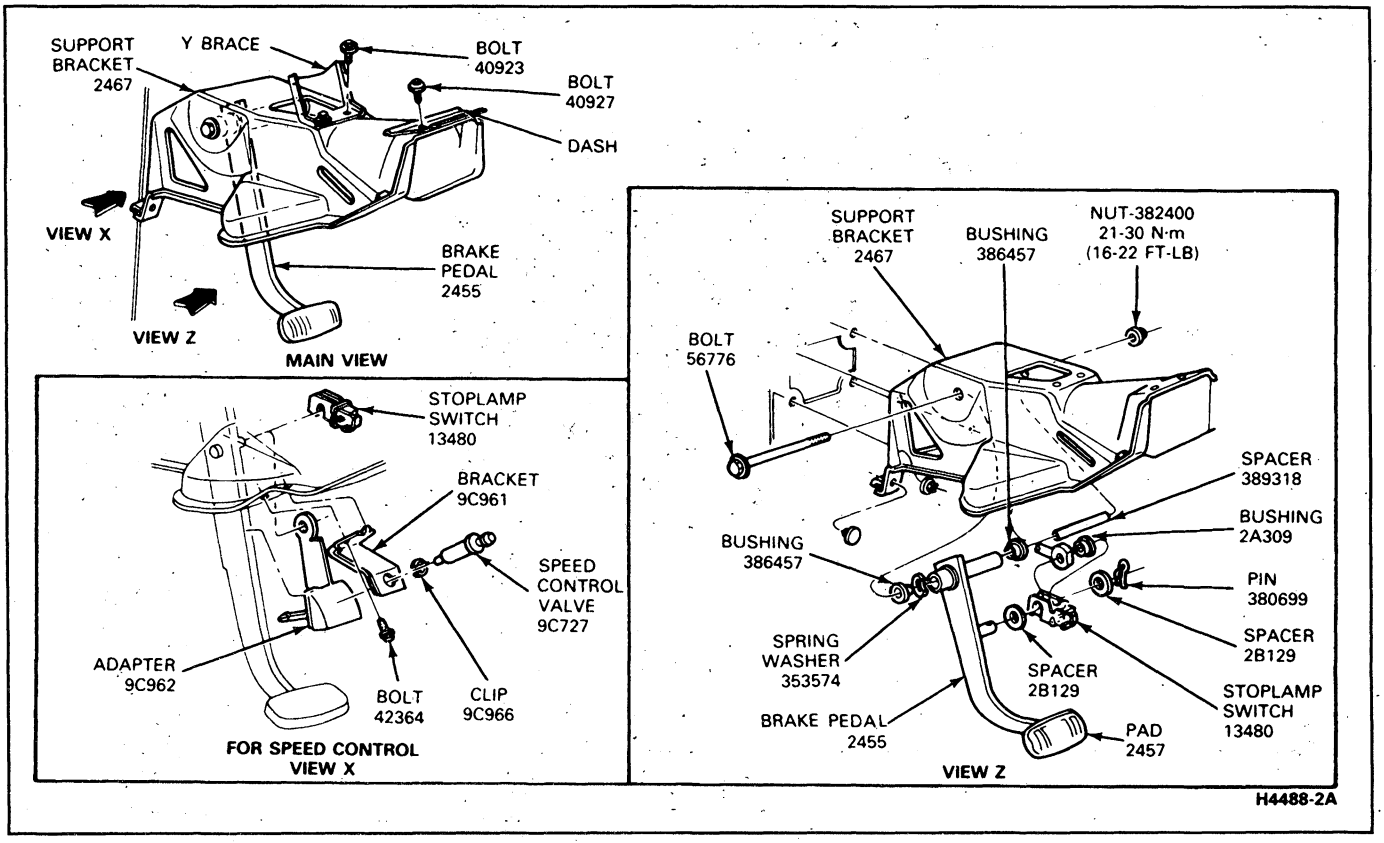


FIG. 12 Brake Pedal Installation—E-150—E-350 with Automatic Transmission

b. If bore is not damaged, rebuild master cylinder assembly using the proper repair kit and the procedure outlined below.

Assembly

1. Clean the master cylinder body with clean isopropyl alcohol to remove any contamination.
2. Dip the repair kit piston assemblies in clean Heavy Duty Break Fluid C6AZ-19542-A or -B (ESA-M6C25-A) or equivalent to lubricate seals.
3. Carefully insert the complete primary piston assembly in the master cylinder bore.
4. Carefully insert the secondary piston assembly in the master cylinder bore.
5. Depress the secondary piston and install the snap ring in the cylinder bore groove.
6. Install the stop-bolt into the bottom of the master cylinder.
7. Install the proportioning valve assembly into the master cylinder.
8. Install the plastic cap on the master cylinder.

Bleeding the Master Cylinder

1. Support the master cylinder body in a vise, and fill both fluid reservoirs with Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or equivalent DOT 3 brake fluid.
2. Install plugs in the front and rear brake outlet ports. Bleed the front brake system first.
3. Loosen the plug in the front brake outlet port. Depress the secondary piston slowly to force the air out of the master cylinder. Tighten plug while piston is depressed or air will enter the master cylinder.
4. Repeat this procedure until air ceases to exit at the outlet port.
5. Repeat steps 3 and 4 for the rear brake outlet port with the front brake outlet plugged.
6. Tighten the plugs and try to depress the piston. Depressing the piston should be harder after all air is expelled.
7. Install the plastic cap.
8. Install the master cylinder in the vehicle and bleed the hydraulic system as outlined in Section 12-01.

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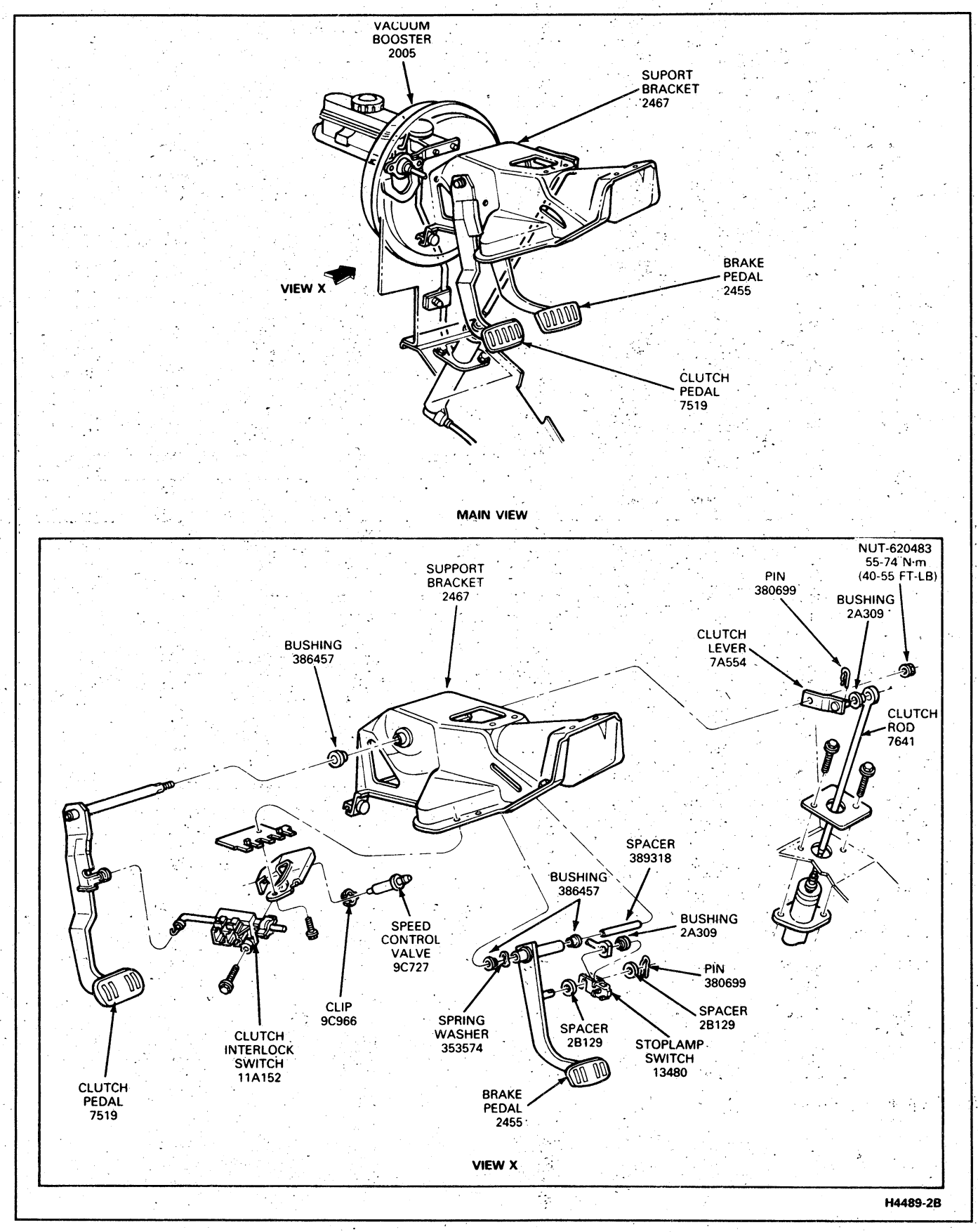


FIG. 13 Brake Pedal Installation—E-150—E-350 with Manual Transmission

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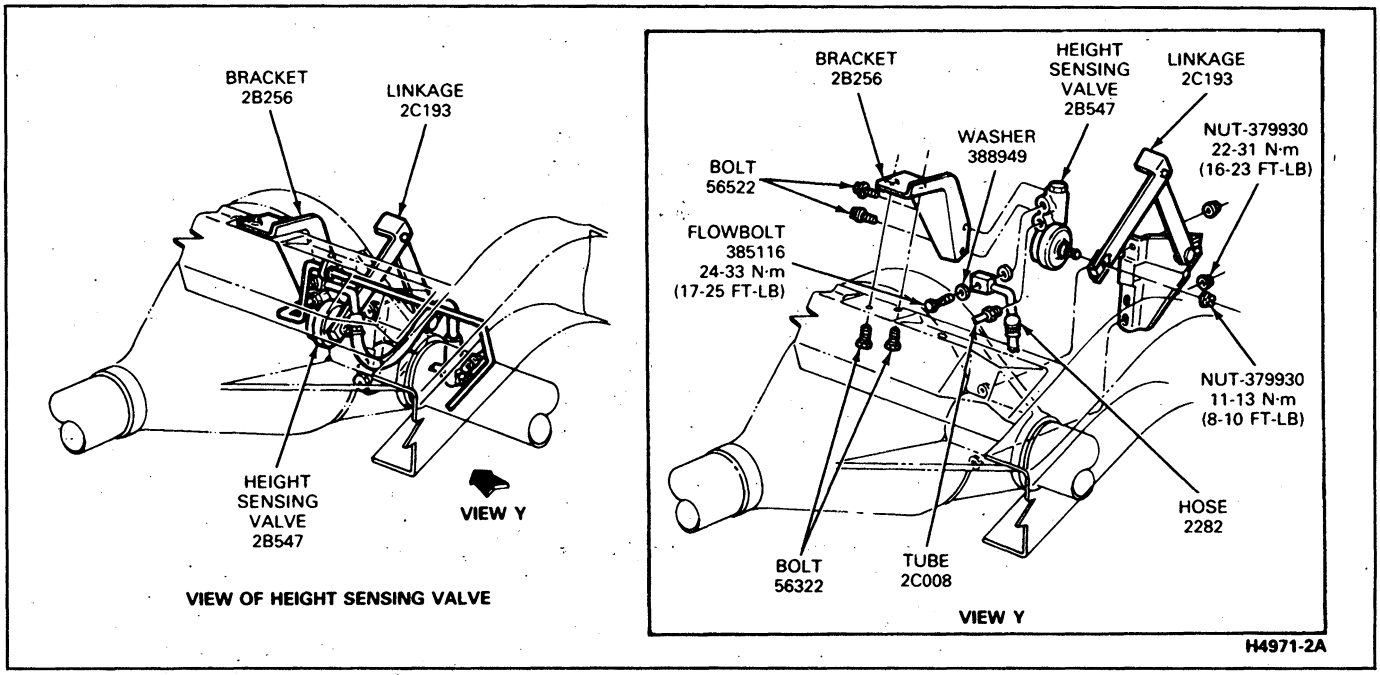


FIG. 14 Height Sensing Valve Installation—E-250—E-350

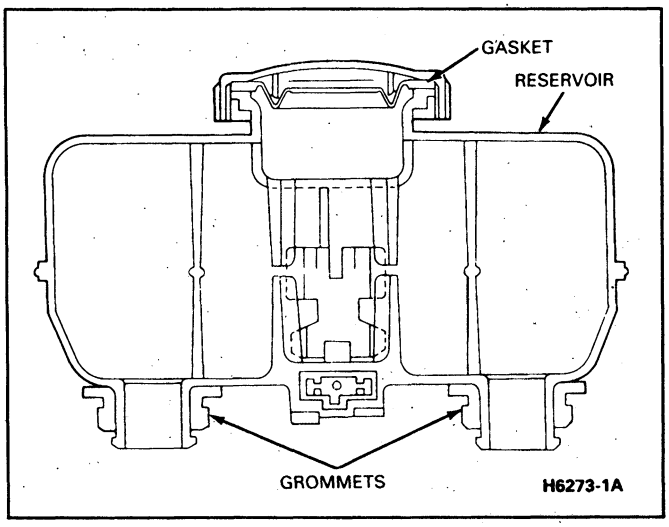


FIG. 15 Plastic Reservoir Assembly

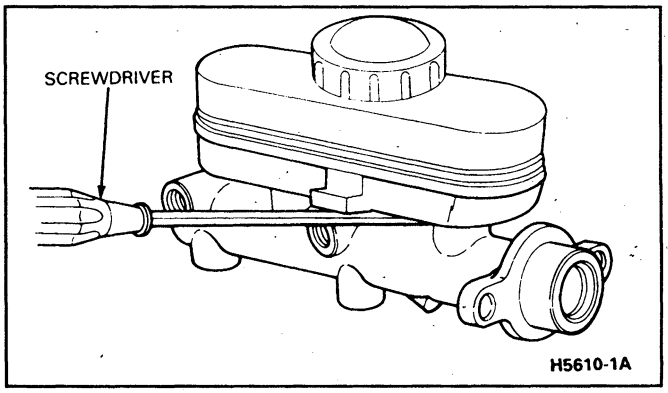


FIG. 16 Reservoir Removal

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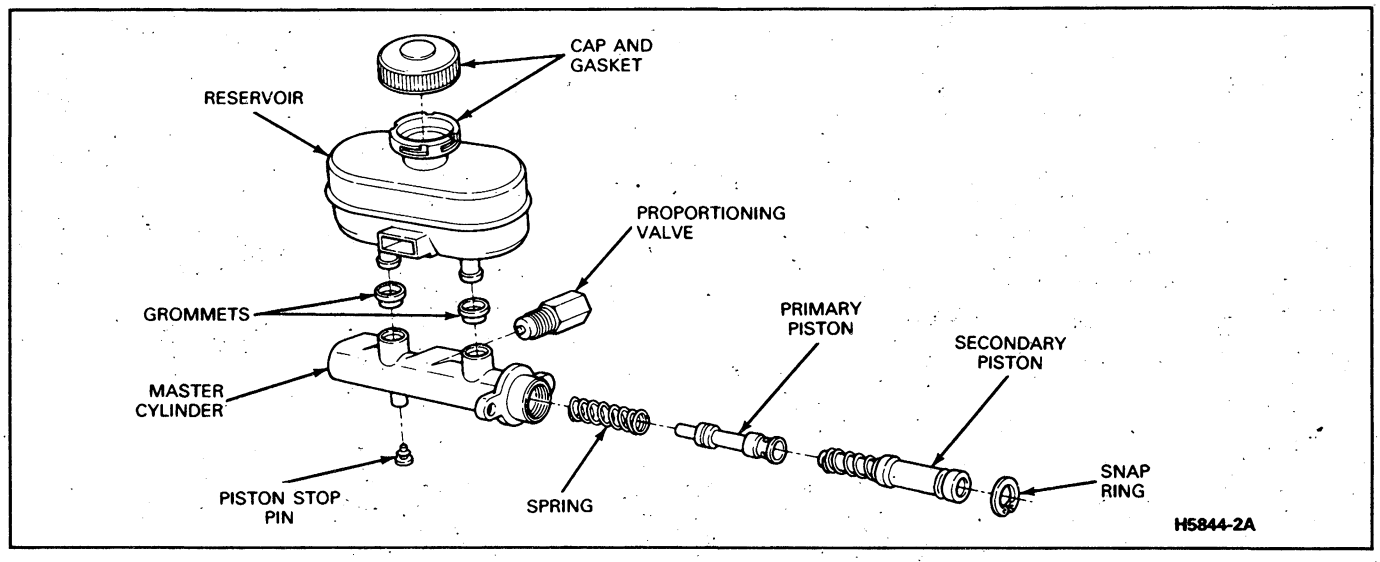


FIG. 17 Master Cylinder

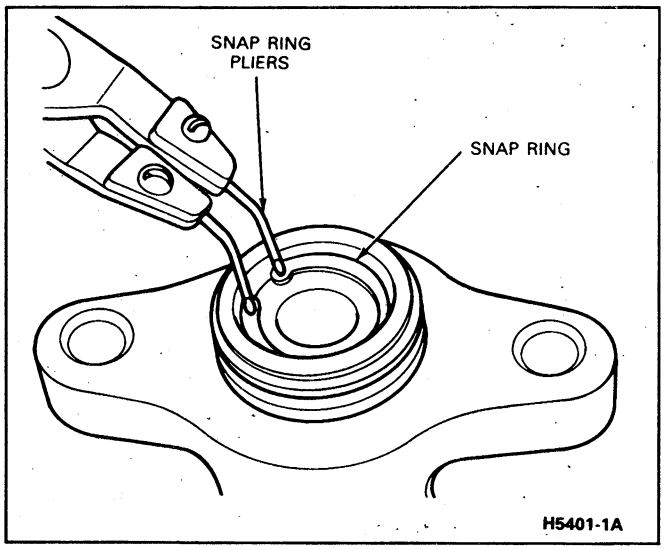


FIG. 18 Removing Snap Ring—Typical

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Application	Torque Limits	
		N-m	Ft-Lbs
Master Cylinder to Vacuum Booster Nut	All	18-33	13-25
Vacuum Booster to Firewall and Pedal Support Nut	All	18-33	13-25
Pedal Shaft Nut — Auto Trans.	All	29-40	21-30
Pedal Shaft Nut — Manual Trans.	F-150—F-350	29-40	21-30
Pedal Shaft Nut — Manual Trans.	E-150—E-350	34-40	25-30

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SECTION 12-31 Rear Antilock Brakes

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
Component Location	12-31-2
Operation	12-31-1
System Self Test	12-31-1
DIAGNOSIS AND TESTING	
Diagnosis Charts	12-31-8
Flashout Codes	12-31-5
Flashout Codes Chart	12-31-6
Troubleshooting Chart	12-31-4
Warning Lights	12-31-5
Warning Lights Condition Chart	12-31-5
DIAGNOSIS AND TESTING (Cont'd.)	
Wiring Diagram	12-31-6
DISASSEMBLY AND ASSEMBLY	12-31-43
REMOVAL AND INSTALLATION	
Excitor Ring	12-31-45
Fuses	12-31-43
RABS Module	12-31-43
RABS Sensor	12-31-44
RABS Valve	12-31-44
SPECIFICATIONS	12-31-45
VEHICLE APPLICATION	12-31-1

VEHICLE APPLICATION

F-150—F-350 and Bronco Vehicles.

DESCRIPTION AND OPERATION

Operation

The Rear Antilock Brake System (RABS) continually monitors rear wheel speed with a sensor mounted on the rear axle. When the teeth on an excitor ring, mounted on the ring gear, pass the sensor pole piece, an AC voltage is induced in the sensor circuit with a frequency proportional to the average rear wheel speed. In the event of an impending lockup condition during braking, the RABS modulates hydraulic pressure to the rear brakes. This inhibits rear wheel lockup.

When the brake pedal is applied, the RABS module senses the drop in rear wheel speed. If the rate of deceleration is too great, indicating that wheel lockup is going to occur, the RABS module activates the electro-hydraulic valve causing the isolation valve to close. With the isolation valve closed, the rear wheel cylinders are isolated from the master cylinder and the rear brake pressure cannot increase. If the rate of deceleration is still too great, the RABS module will energize the dump solenoid with a series of rapid pulses to bleed off rear wheel cylinder fluid into an accumulator built into the RABS valve. This will reduce the rear wheel cylinder pressure and allow the rear wheels to spin back up to vehicle speed. Continuing under RABS module control, the dump and isolation solenoids will be pulsed in a manner that will keep the rear wheels rotating while still maintaining high levels of deceleration during braking.

At the end of the stop, when the operator releases the brake pedal, the isolation valve de-energizes and any fluid in the accumulator is returned to the master cylinder. Normal brake operation is resumed.

System Self Test

The RABS module performs system tests and self-tests during start-up and normal operation. The valve, sensor, and fluid level circuits are monitored for proper operation. If a fault is found the RABS will be deactivated and the REAR ANTILOCK light will be illuminated. Most faults will cause the light to stay illuminated until the ignition is turned off. While the light is illuminated a diagnostic flashout code may be obtained. However, there are certain faults (those associated with the fluid level switch or loss of power to the module) that will cause the system to be deactivated and the REAR ANTILOCK light to be illuminated but will not provide a diagnostic flashout code will be available.

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DESCRIPTION AND OPERATION (Continued)

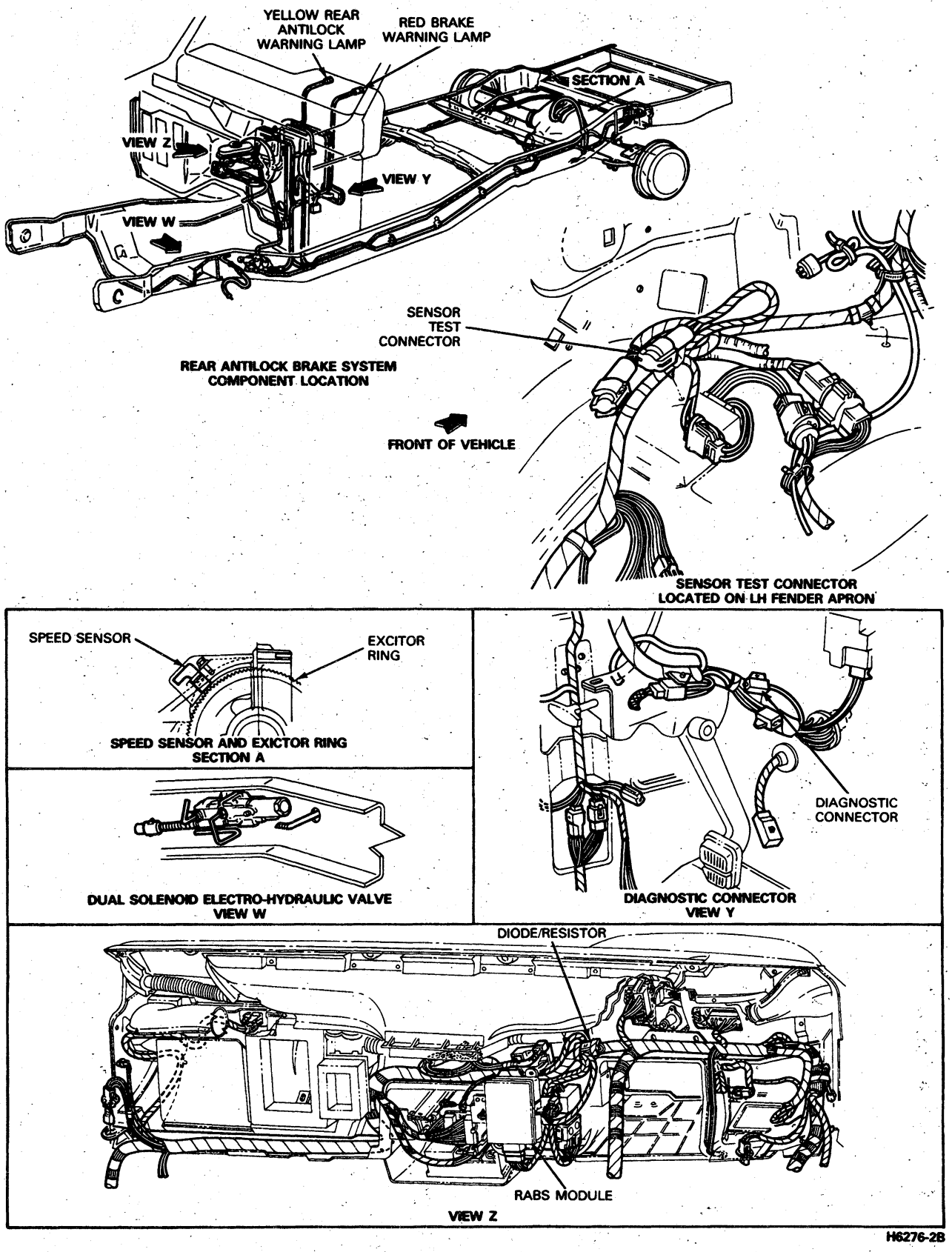
Component Location

The RABS consists of the following components:

- RABS module located in the cab to the right of the brake pedal under the upper dash panel.
- RABS valve (dual solenoid electro-hydraulic) valve located on the left frame rail just behind the number 1 crossmember.
- RABS speed sensor and excitor ring located in the rear axle carrier.
- Yellow REAR ANTILOCK warning light in the instrument cluster.
- RABS diagnostic connector located in the cab and clipped on the main instrument panel wiring harness about six inches from the firewall near the parking brake pedal.
- Diode/resistor element located on the main trunk of the instrument panel wiring harness where the RABS module connector pigtail intersects the main trunk.
- Sensor test connector with cap located under the hood on the left wheel well.

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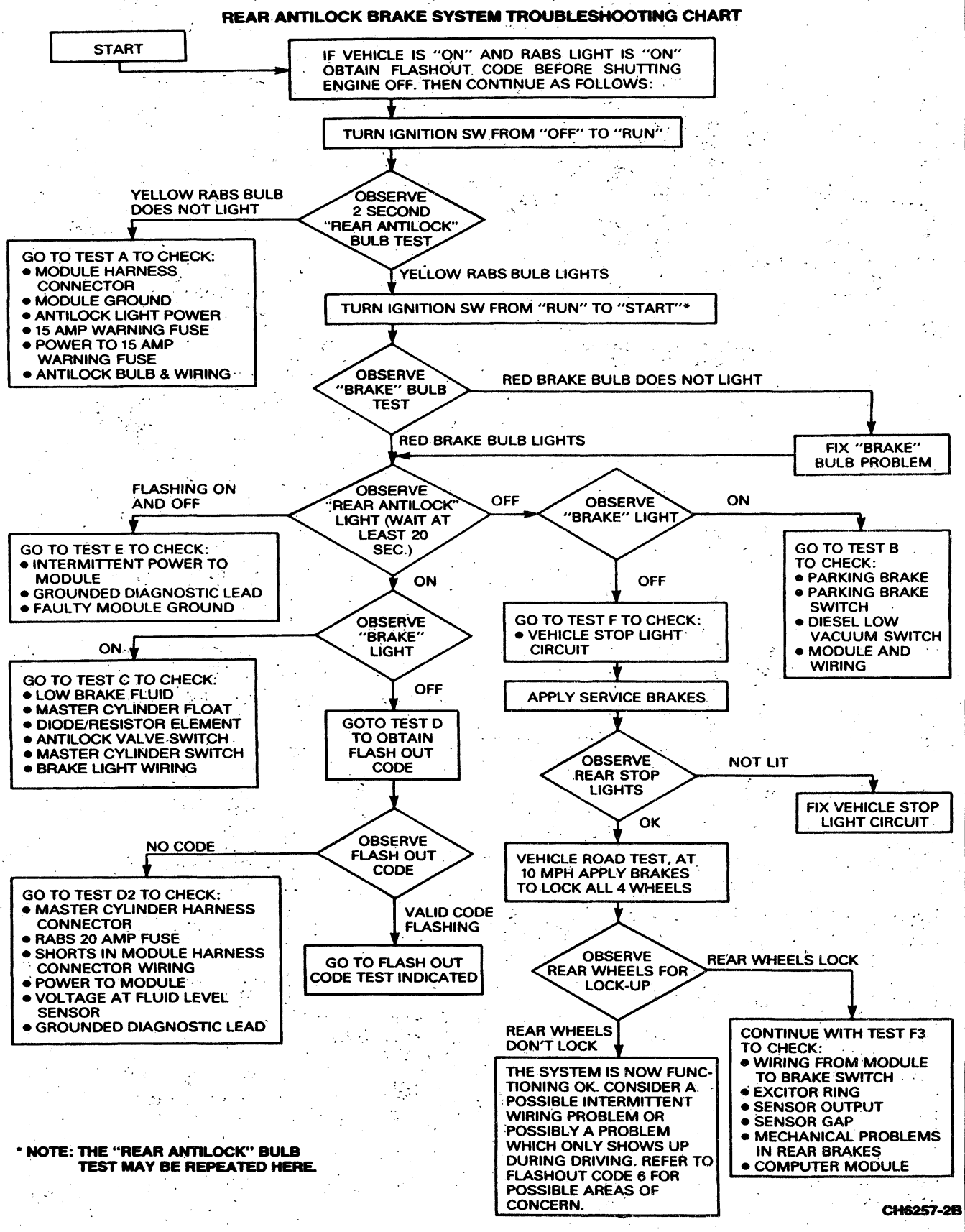
DESCRIPTION AND OPERATION (Continued)



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DIAGNOSIS AND TESTING

Troubleshooting Chart



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DIAGNOSIS AND TESTING (Continued)

Following the sequence developed in the RABS Troubleshooting Chart will ensure accurate and efficient problem diagnosis and correction.

CAUTION: Following the wrong sequence or bypassing steps will lead to unnecessary replacement of parts and/or incorrect resolution of the symptom.

NOTE: If the yellow REAR ANTILOCK light is on, obtain the flashout code before shutting off the vehicle. Failure to do so may result in the loss of the code when the key is turned to the off position. Refer to Flashout Codes later in this Section for a detailed explanation.

Warning Lights

The RABS uses both the BRAKE and REAR ANTILOCK instrument panel warning lights to alert the driver to a system malfunction. Both lights must be working properly to assist in problem diagnosis. The red BRAKE warning light is used to indicate a low fluid level condition, parking brake applied condition or, for vehicles equipped with diesel engines, a low vacuum condition. To check this light, insert the key in the ignition lock cylinder and turn it to the start position. The light should glow in this position. If it fails to glow, service of the electrical system is required.

NOTE: If the red brake light continues to glow after the key is in the run position, repair the brake system as required. If the brake system checks out OK, follow the Troubleshooting Chart to diagnose the problem.

The yellow REAR ANTILOCK warning light is used to indicate a malfunction in and a deactivation of the RABS. To check this light, insert the key in the ignition lock cylinder and turn it to the on or start positions. The light should perform a self-check, glowing for approximately 2 seconds. If the light fails to glow or continues to glow after 2 seconds, refer to the Brake and Antilock Warning Lights Condition Chart for the proper diagnostic and testing procedure.

Warning Lights Condition Chart

The Brake and Antilock Warning Lights Condition Chart defines which test to be used to diagnose a problem depending on the condition of the BRAKE and REAR ANTILOCK warning lights.

Flashout Codes

Whenever the yellow REAR ANTILOCK light comes on during normal operation, a flashout code may be obtained to aid in problem diagnosis. If the vehicle is shut off before the code is read, the code will be lost. In some cases the code may reappear when the vehicle is restarted. In other cases the vehicle may have to be driven to reproduce the problem and, if the problem was associated with an intermittent condition, it may be difficult to reproduce. Therefore, whenever possible, it is recommended that the code be read before the vehicle is shut off.

WARNING: PLACE BLOCKS BEHIND THE REAR WHEELS AND IN FRONT OF THE FRONT WHEELS TO PREVENT THE VEHICLE FROM MOVING WHILE THE FLASHOUT CODE IS BEING TAKEN.

NOTE: If the red BRAKE light is also on, due to a grounding of the fluid level circuit (perhaps low brake fluid), no flashout code will be flashed and the REAR ANTILOCK light will remain on steadily.

NOTE: If there is more than one system fault only the first recognized flashout code may be obtained.

Obtaining The Flashout Code

A flashout code may be obtained **only** when the yellow REAR ANTILOCK light is **on**. No code will be flashed if the system is OK.

Before obtaining the flashout code, drive the vehicle to a level area, and place the shift lever in PARK for automatic transmissions and neutral for manual transmissions.

Notice whether the red BRAKE light is on or not (for future reference) and then apply the parking brake.

Keep the ignition key in the ON position so that the code will not be lost.

WARNING: PLACE BLOCKS BEHIND THE REAR WHEELS AND IN FRONT OF THE FRONT WHEELS TO PREVENT THE VEHICLE FROM MOVING WHILE THE FLASHOUT CODE IS BEING TAKEN.

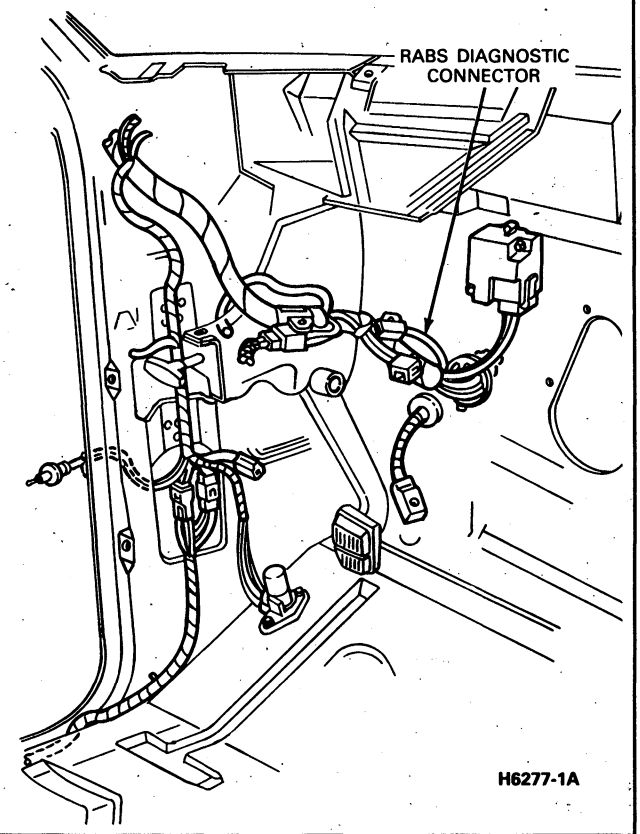
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DIAGNOSIS AND TESTING (Continued)

To obtain the flashout code, locate the RABS diagnostic connector (with the black/orange wire), and attach a jumper wire to it. Momentarily ground it to the chassis. When the ground is made and then broken the REAR ANTILOCK light should begin to flash.

NOTE: If the red BRAKE light was on (as noticed before the parking brake was applied) the problem may be with the low fluid level circuit and, in this case, no flashout code will be flashed and the light will remain on steadily.

The code consists of a number of short flashes and ends with a long flash. Count the short flashes and include the following long flash in the count to obtain the code number. For example, three short flashes followed by one long flash indicates Flashout Code Four. The code will continue to repeat itself until the key is turned off. It is recommended that the code be verified by reading it several times. In addition, the first code flashed may be too short because it may have been started in the middle. It should be ignored.



Flashout Codes Chart

The possible flashout codes are listed and explained in the FLASHOUT CODES CHART. Note that Codes 1, and 16 are not used.

When a code has been obtained go to the Test indicated by the number of flashes. For example, if the flashout code is nine, go to Flashout Code 9 for the next step in diagnosing the problem.

Wiring Diagram

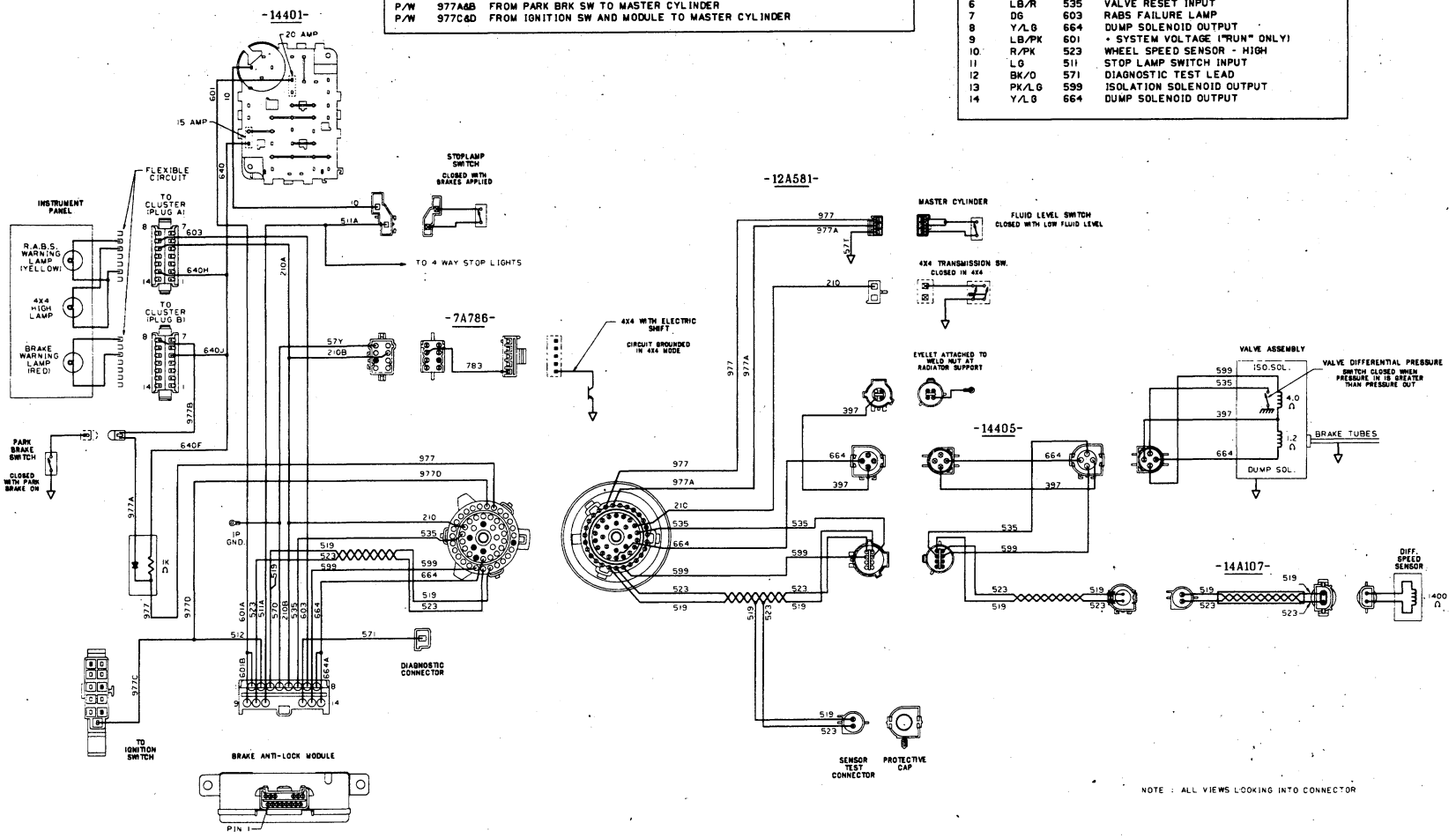
A wiring diagram is provided which represents the RABS electrical system. The diagram provides the wire circuit numbers, color codes, connectors, and connections to principal system components. If, after following a particular test procedure, the result is not as indicated, the problem may be located in the wiring itself. This diagram will assist in diagnosing these problems.

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DIAGNOSIS AND TESTING (Continued)

ADDITIONAL WIRE CIRCUIT NUMBERS USED		
COLOR	WIRE #	FUNCTION
LG/R	10	CONTINUOUS HOT TO STOP LAMP SWITCH
BK	57T	FLUID LEVEL SW GROUND
BK/W	397	RABS VALVE GROUND TO BATTERY TERMINAL
R/Y	640	HOT IN "RUN" OR "START" TO FLUID LEVEL SWITCH
GY	783	4X4 SHIFT ON THE FLY LIGHT SWITCH
P/W	977A&B	FROM PARK BRK SW TO MASTER CYLINDER
P/W	977C&D	FROM IGNITION SW AND MODULE TO MASTER CYLINDER

14 PIN CONNECTOR			
PIN #	COLOR	WIRE #	FUNCTION
1	LB/PK	601	HOT IN "RUN" ONLY (+ SYSTEM VOLTAGE)
2	T/LG	512	BRAKE FLUID LEVEL SWITCH
3	LG/BK	519	WHEEL SPEED SENSOR - LOW
4	BK/W	570	MODULE GROUND
5	LB	210	4X4 SIGNAL INPUT (LOW WHEN IN 4X4)
6	LB/R	535	VALVE RESET INPUT
7	DG	603	RABS FAILURE LAMP
8	Y/LG	664	DUMP SOLENOID OUTPUT
9	LB/PK	601	+ SYSTEM VOLTAGE ("RUN" ONLY)
10	R/PK	523	WHEEL SPEED SENSOR - HIGH
11	LG	511	STOP LAMP SWITCH INPUT
12	BK/O	571	DIAGNOSTIC TEST LEAD
13	PK/LG	599	ISOLATION SOLENOID OUTPUT
14	Y/LG	664	DUMP SOLENOID OUTPUT



NOTE : ALL VIEWS LOOKING INTO CONNECTOR

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DIAGNOSIS AND TESTING (Continued)

Diagnosis Charts

BRAKE AND ANTILOCK WARNING LAMPS CONDITION CHART

Condition	Action to Take
Yellow ANTILOCK Light Off and Does Not Self-Check	See Test A
Yellow ANTILOCK Light Off, and ANTILOCK Light Does Self-Check, Red BRAKE Light On	See Test B
Yellow ANTILOCK Light On and Red BRAKE Light On	See Test C
Yellow ANTILOCK Light On, Red BRAKE Light Off	See Test D
Yellow ANTILOCK Light Flashing, Red BRAKE Light Off	See Test E
Rear Wheels Lock with Hard Stops — Both Lamps Functioning Properly (Light Self-Checks are OK and Lights are OFF)	See Test F
Flashout Code is Known	See Flashout Codes Chart

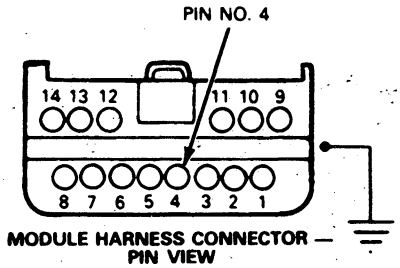
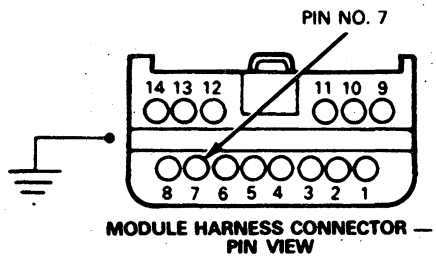
CAUTION: WHEN CHECKING RESISTANCE IN THE ANTILOCK BRAKE SYSTEM, ALWAYS DISCONNECT THE BATTERY. IMPROPER RESISTANCE READINGS WILL OCCUR WITH THE VEHICLE BATTERY CONNECTED. **CH6278-2A**

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light Off and Does Not Self-Check

Test A

TEST STEP	RESULT ▶	ACTION TO TAKE
A1 MODULE HARNESS CONNECTOR		
• Check to make sure module harness is fully plugged into computer module.	Harness is fully plugged in ▶	GO to Test **A2**.
	Harness is not fully plugged in ▶	CONNECT harness to module.
A2 COMPUTER MODULE GROUND		
• Check for good computer module ground: 1. Disconnect Battery 2. Remove harness connector from module. 3. Set ohmmeter on the 200 ohm scale. 4. Check for resistance between harness connector pin 4 and chassis ground  MODULE HARNESS CONNECTOR — PIN VIEW **CAUTION: WHEN CHECKING RESISTANCE IN THE ANTILOCK SYSTEM, ALWAYS DISCONNECT THE POSITIVE (+) TERMINAL OF THE BATTERY. IMPROPER RESISTANCE MAY OCCUR WITH THE VEHICLE BATTERY CONNECTED.**	Resistance less than 1 ohm ▶	GO to Test **A3**.
	Resistance 1 ohm or greater ▶	CHECK for open in module ground wire. CHECK for loose, dirty or broken connector pins.
A3 ANTILOCK LIGHT POWER		
• Check for voltage to ANTILOCK light: 1. Reconnect the battery. 2. Set voltmeter on 20 VDC scale position. 3. Turn ignition to the on position. 4. Check voltage between harness connector pin 7 and a known good chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage greater than 9V ▶	REPLACE Module.
	Voltage less than 9V ▶	GO to Test **A4**

CH6819-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light Off and Does Not Self-Check (Cont'd)

Test A

TEST STEP	RESULT ▶	ACTION TO TAKE
A4 RABS 15 AMP LIGHT FUSE		
• Remove and inspect RABS 15 amp light fuse.	Fuse is OK ▶	REPLACE fuse and GO to Test **A5**.
	Fuse is blown ▶	CHECK for short to ground between fuse panel and warning lamps. REPAIR short and replace 15 amp fuse.
A5 POWER TO RABS LIGHT FUSE		
• Check for voltage to fuse. 1. Set voltmeter to 20 VDC scale. 2. Turn ignition to the on position. 3. Check voltage between panel fuse connector and known good chassis ground.	Voltage greater than 9V ▶	GO to Test **A6**.
	Voltage less than 9V ▶	REPAIR fuse panel or vehicle electrical system.
A6 RABS LIGHT BULB		
• Check RABS light bulb.	Bulb is OK ▶	REPAIR open between RABS light fuse and pin 7 of the module wiring harness connector.
	Bulb is not OK ▶	REPLACE bulb.

CH6280-2A

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DIAGNOSIS AND TESTING (Continued)

Red BRAKE Light On, Yellow ANTILOCK Light Off, and ANTILOCK Light Does Self-Check — Test B

TEST STEP	RESULT	ACTION TO TAKE
B1 PARKING BRAKE		
• Check parking brake application: 1. Turn ignition key to the on position. 2. Check the parking brake pedal and release if applied.	BRAKE light goes off ▶	PERFORM road test. If lockup occurs GO to Test **B2**.
	BRAKE light stays on ▶	GO to Test **B2**.
B2 PARKING BRAKE SWITCH		
• Check parking brake switch: 1. Disconnect the parking brake switch connector.	BRAKE light goes off ▶	ADJUST parking brake or REPLACE parking brake switch.
	BRAKE light remains on ▶	Diesel vehicles GO to Test **B3**. Gas vehicles GO to Test **B4**.
B3 DIESEL LOW VACUUM SWITCH		
• Check for low brake vacuum: 1. Disconnect vacuum warning switch connector.	BRAKE light goes off ▶	REFER to vacuum pump diagnosis in Section 12-56 to correct problem in vacuum system.
	BRAKE light stays on ▶	GO to Test **B4**.
B4 MODULE AND WIRING		
• Remove module harness connector from module.	BRAKE light goes off ▶	REPLACE the computer module.
	If BRAKE light remains on ▶	CHECK for short to ground in wiring from BRAKE light to the RABS diode/resistor.

CH6281-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On and Red BRAKE Light On — Test C

TEST STEP	RESULT	ACTION TO TAKE
C1 LOW BRAKE FLUID		
• Check the brake fluid level at the master cylinder reservoir.	Brake fluid level OK ▶	GO to Test **C2**.
	Brake fluid level low ▶	CHECK for fluid leaks in vehicle brake system and repair as required. Fill master cylinder to required level.
C2 MASTER CYLINDER FLOAT		
• Check master cylinder float for buoyancy: 1. Remove cap from master cylinder reservoir. 2. Using a clean steel implement, push down on float in reservoir.	Float moves down ▶	GO to Test **C3**.
	Float does not move down (sits at the bottom of the reservoir) ▶	REPLACE master cylinder reservoir. REFER to Section 12-30, Brake Pedal, Master Cylinder and Valves for procedure.
C3 DIODE/RESISTOR ELEMENT		
• Check for proper functioning of the diode/resistor element. 1. Turn ignition key to the on position. 2. Check parking brake and release if applied.	Both the ANTILOCK and BRAKE warning lamps go off ▶	REPLACE RABS diode/resistor element.
	Both the ANTILOCK and BRAKE warning lamps stay on ▶	GO to Test **C4**.
C4 DIODE/RESISTOR ELEMENT CONTINUED		
• Continue to check for proper functioning of the diode/resistor element. 1. Remove the parking brake switch and the diesel low vacuum switch, if so equipped.	Both the ANTILOCK and BRAKE warning lamps go off ▶	REPLACE RABS diode/resistor element.
	Both the ANTILOCK and BRAKE warning lamps stay on ▶	GO to Test **C5**.

CH6282-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On and Red BRAKE Light On — Cont'd

Test C

TEST STEP	RESULT ▶	ACTION TO TAKE
C5 ANTILOCK VALVE SWITCH		
• Obtain the flashout code as described in Diagnosis and Testing in this Section.	Flashout code is obtained ▶	REFER to Flashout Codes Charts in this Section.
	ANTILOCK and BRAKE warning lamps stay on steady ▶	GO to Test **C6**.
C6 MASTER CYLINDER SWITCH		
• Check for proper functioning of the master cylinder fluid level indicator switch: 1. Remove the connector from the master cylinder. 2. Connect a jumper wire between the two purple/white wires in the connector. 3. Turn the ignition key to the on position.	ANTILOCK and BRAKE warning lamps stay on ▶	GO to Test **C7**.
	ANTILOCK and BRAKE warning lamps go off ▶	REPLACE the master cylinder reservoir. REFER to Section 12-30, Brake Pedal, Master Cylinder and Valves for procedure.
C7 BRAKE LIGHT WIRING		
• Check for shorts in brake light wiring. 1. Disconnect module harness connector from module. 2. Turn ignition key to the on position.	ANTILOCK light goes off and BRAKE light stays on ▶	CHECK for short to ground in the 977 circuit. REFER to wiring diagram in this Section.
	Both ANTILOCK and BRAKE warning lamps go off ▶	REPLACE module.

CH6283-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On, Red BRAKE Light Off — Test D

TEST STEP	RESULT	ACTION TO TAKE
D1 OBTAIN THE FLASHOUT CODE		
• Obtain the flashout code as described in Diagnosis and Testing in this Section.  RABS DIAGNOSTIC CONNECTOR — PIN VIEW	Flashout code cannot be obtained ▶	GO to Test **D2**.
	Flashout code is obtained ▶	Refer to the Flashout Code Charts in this Section.
D2 MASTER CYLINDER CONNECTOR		
• Make sure master cylinder connector is fully plugged in.	Master cylinder connector is not fully plugged in ▶	PLUG in the master cylinder connector.
	Master cylinder connector is plugged in ▶	GO to Test **D3**.
D3 RABS 20 AMP FUSE		
• Remove and inspect the RABS 20 amp fuse.	Fuse is OK ▶	REPLACE Fuse. GO to Test **D4**.
	Fuse is blown ▶	Short to ground between the fuse panel and the module wiring harness connector. REPAIR short in the 601 circuit and REPLACE the 20 amp. fuse. REFER to the Wiring Diagrams in this Section.
D4 SHORTS IN MODULE HARNESS CONNECTOR WIRING		
• Check wiring for short to ground: 1. Turn ignition switch to the on position. 2. Remove the module harness connector from the module. 3. Observe the REAR ANTILOCK light.	Light goes off ▶	GO to Test **D5**.
	Light remains on ▶	CHECK for a short to ground in the 603 Circuit. REFER to Wiring Diagram in this Section.

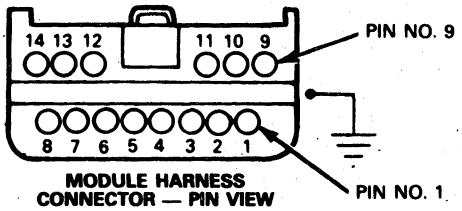
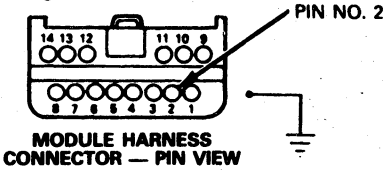
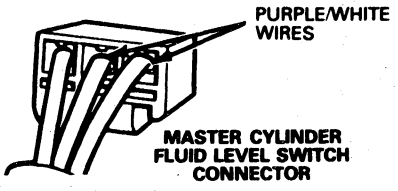
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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On, Red BRAKE Light Off (Cont'd)

Test D

TEST STEP	RESULT ▶	ACTION TO TAKE
D5 POWER TO THE MODULE		
• Check for an open in the circuit supplying power to the module: 1. Set the voltmeter on the 20 VDC scale. 2. Turn the ignition switch to the on position. 3. Measure the voltage between pin 1 (or pin 9) and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage less than 9V. ▶ Voltage greater than 9V. ▶	REPAIR the open in the 601 circuit or power to the fuse panel. See Wiring Diagram. GO to Test **D6**.
D6 VOLTAGE AT THE FLUID LEVEL CIRCUIT		
• Check the voltage from the fluid level switch circuit: 1. Set the voltmeter on the 20 VDC Scale. 2. Turn the ignition switch to the on position. 3. Measure the voltage between pin 2 and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage less than 8V. ▶ Voltage greater than 8V. ▶	GO to Test **D7**. GO to Test **D8**.
D7 FLUID LEVEL SENSOR AND WIRING		
• Check for voltage at the fluid level sensor: 1. Set voltmeter on the 20 VDC scale. 2. Turn the ignition switch to the on position. 3. Measure the voltage at each of the purple/white wires at the back of the master cylinder fluid level switch connector without disconnecting the connector.  MASTER CYLINDER FLUID LEVEL SWITCH CONNECTOR	Voltage greater than 8V at both wires. ▶ Voltage less than 8V at both wires. ▶ Voltage greater than 8V at one wire and less than 8V at the other wire. ▶	CHECK for open in 977 circuit. REPLACE diode resistor element or open in 640 circuit. CHANGE the master cylinder reservoir. REFER to Section 12-30, Brake Pedal, Master Cylinder and Valves for procedure.

CH6285-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On, Red BRAKE Light Off (Cont'd)

Test D

TEST STEP	RESULT ▶	ACTION TO TAKE
D8 GROUNDED DIAGNOSTIC LEAD		
• Check the voltage at the diagnostic lead. 1. Reconnect the module harness connector. 2. Set the voltmeter on the 20 VDC scale. 3. Turn the ignition to the on position. 4. Measure the voltage between the diagnostic lead and chassis ground.  RABS DIAGNOSTIC CONNECTOR PIN VIEW	Voltage is less than 1V ▶ Voltage is greater than 1V ▶	CHECK for a short in the 571 diagnostic circuit. If no short is found, GO to Test **D9**. GO to Test **D9**.
D9 COMPUTER MODULE		
• Replace computer module and retest.		

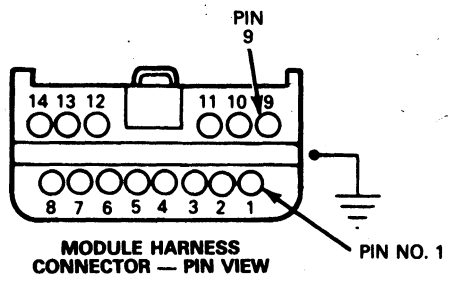
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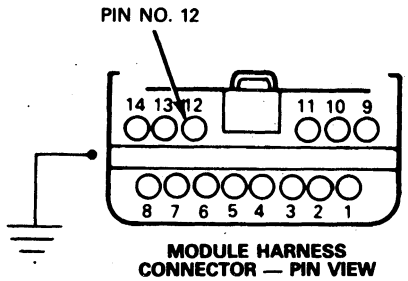
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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light Flashing, Red BRAKE Light Off — Test E

TEST STEP	RESULT ▶	ACTION TO TAKE
E1 INTERMITTENT POWER TO MODULE		
• Check for intermittent open in the 601 circuit, power to module. 1. Remove the module harness connector from the module. 2. Set the voltmeter on the 20 VDC scale. 3. Turn the ignition to the on position. 4. Shake the instrument panel harness. Check for battery voltage between pin 1 (or pin 9) and chassis ground.	Voltage is steady and greater than 9V ▶ Voltage is intermittent or less than 9V ▶	GO to Test **E2**. REPAIR break in the 601 circuit. REFER to Wiring Diagram in this Section.
E2 GROUNDED DIAGNOSTIC LEAD		
• Check for an intermittent ground to chassis in the diagnostic lead circuit: 1. Turn the ignition switch off. 2. Disconnect the battery. 3. Set the ohmmeter on the 200K ohm scale. 4. Shake the instrument panel harness and check the resistance between pin 12 and chassis ground.	Resistance is steady and greater than 100K ohms ▶ Resistance is below 100K ohms or fluctuates ▶	GO to Test **E3**. REPAIR short in the 571 circuit. REFER to Wiring Diagram in this Section.





CH6286-2B

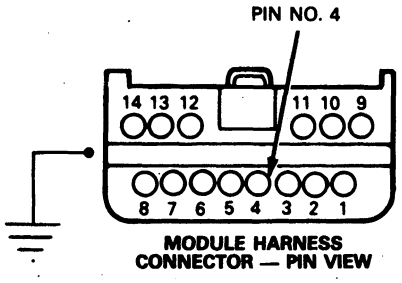
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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light Flashing, Red BRAKE Light Off — Cont'd

Test E

TEST STEP	RESULT ▶	ACTION TO TAKE
E3 FAULTY MODULE GROUND		
• Check for intermittent or poor module ground: 1. Disconnect the battery. 2. Set the voltmeter on the 200 ohm scale. 3. Shake the instrument panel harness and check the resistance between pin 4 of the module harness connector and chassis ground.	Resistance is less than 1 ohm and steady ▶	REPLACE Module.
	Resistance is greater than 1 ohm or fluctuates ▶	REPAIR poor ground in the 570 circuit. REFER to Wiring Diagram in this Section.



MODULE HARNESS CONNECTOR — PIN VIEW

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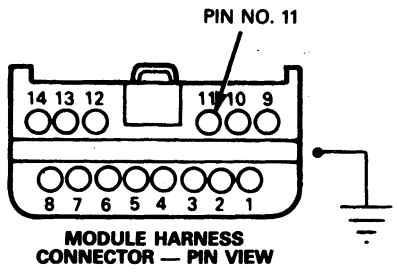
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DIAGNOSIS AND TESTING (Continued)

Rear Wheels Lock with Hard Stops — Both Lamps Functioning Properly

Test F

TEST STEP	RESULT ▶	ACTION TO TAKE
F1 STOPLAMPS		
• Check for stoplamp operation: 1. Apply the service brakes and observe the rear brakelamps.	Rear stoplamps not illuminated ▶	REPAIR the stoplamp circuit.
	Rear stoplamps OK ▶	GO to Test **F2**.
F2 VEHICLE ROAD TEST		
• Perform a low speed vehicle road test: 1. At approximately 10 mph apply the service brakes in an attempt to lock all four wheels while observing the left rear wheel in the side mirror.	Rear wheels lock ▶	GO to Test **F3**.
	Rear wheels do not lock ▶	The system is now functioning OK. Consider a possible intermittent wiring problem or possibly a problem which only shows up during driving. REFER to Flashout Code 6 in this Section.
F3 WIRING FROM MODULE TO BRAKE SWITCH		
• Check for an open between the brake switch and the module: 1. Turn the ignition off. 2. Set the voltmeter on the 20 VDC scale. 3. Remove the module harness connector. 4. Measure the voltage between pin 11 and chassis ground while stepping on the brake pedal.	Voltage is less than 9V ▶	REPAIR the open in the 511 circuit.
	Voltage is 9V or more ▶	GO to Test **F4**.
F4 EXCITOR RING INSPECTION		
• Remove sensor from carrier and check for: 1. Presence of the excitor ring 2. Condition of the teeth.	Ring is present with the teeth intact ▶	REINSTALL the sensor and GO to Test **F5**.
	Ring is not present or the teeth are damaged ▶	REPAIR axle. REFER to the appropriate Section in Group 15 for procedure.



MODULE HARNESS CONNECTOR — PIN VIEW

CH6287-2B

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DIAGNOSIS AND TESTING (Continued)

Rear Wheels Lock with Hard Stops — Both Lamps Functioning Properly (Continued)

Test F

TEST STEP	RESULT ▶	ACTION TO TAKE
F5 SENSOR OUTPUT		
• Check for low sensor signal output: 1. Set the voltmeter on the 2000 mV AC scale. 2. Position the vehicle on the hoist and raise the rear wheels off the ground. 3. Remove the cap from the sensor test connector and connect the voltmeter across the connector leads. 4. Start the engine and turn the rear wheels at 5 mph. 5. Measure the voltage output of the sensor.  CONNECTOR PINS **SENSOR TEST CONNECTOR – PIN VIEW**	Voltage is 650 mV (RMS) or greater ▶ Voltage is less than 650 mV (RMS) ▶	REINSTALL the sensor test connector cap and GO to Test **F7**. REPLACE the sensor, RETEST, and REINSTALL the sensor test connector cap. If the voltage is still low, GO to Test **F6**.
F6 SENSOR GAP		
• Determine the sensor gap: 1. Remove the sensor from the carrier. 2. Measure the height of the sensor pole piece from the mounting face of the sensor flange. Pole should be 1.07-1.08 inch. 3. Measure the depth to the top of the excitor ring teeth from the sensor mounting face on the carrier. 4. Subtract the two measurments. This is the sensor gap.	Gap is less than 0.050 inches ▶ Gap is greater than 0.050 inches ▶	GO to Test **F7**. The gap is too large. CHECK for defective sensor or carrier housing.
F7 MECHANICAL PROBLEMS IN REAR BRAKES		
• Check the rear brakes for mechanical problems such as grabbing, locking or pulling.	Rear Brakes OK ▶ Rear brakes lock, grab or pull ▶	GO to Test **F8**. REPAIR and RETEST.
F8 COMPUTER MODULE		
• Replace computer module and retest.		

CH6315-2A

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DIAGNOSIS AND TESTING (Continued)

FLASHOUT CODES CHART

CONDITION	ACTION TO TAKE
No Flashout Code	See Flashout Code 0
Yellow REAR ANTILOCK Light Flashes 1 Time This Code Should Not Occur	See Flashout Code 1
Yellow REAR ANTILOCK Light Flashes 2 Times Open Isolate Circuit	See Flashout Code 2
Yellow REAR ANTILOCK Light Flashes 3 Times Open Dump Circuit	See Flashout Code 3
Yellow REAR ANTILOCK Light Flashes 4 Times Red Brake Warning Light Illuminated RABS Valve Switch Closed	See Flashout Code 4
Yellow REAR ANTILOCK Light Flashes 5 Times System Dumps Too Many Times in 2WD (2WD and 4WD vehicles) Condition Occurs While Making Normal or Hard Stops. Rear Brake May Lock	See Flashout Code 5
Yellow REAR ANTILOCK Light Flashes 6 Times (Sensor Signal Rapidly Cuts In and Out) Condition Only Occurs While Driving	See Flashout Code 6
Yellow REAR ANTILOCK Light Flashes 7 Times No Isolate Valve Self Test	See Flashout Code 7
Yellow REAR ANTILOCK Light Flashes 8 Times No Dump Valve Self Test	See Flashout Code 8
Yellow REAR ANTILOCK Light Flashes 9 Times High Sensor Resistance	See Flashout Code 9
Yellow REAR ANTILOCK Light Flashes 10 Times Low Sensor Resistance	See Flashout Code 10
Yellow REAR ANTILOCK Light Flashes 11 Times Stop Lamp Switch Circuit Defective. Condition Indicated Only When Driving Above 35 mph	See Flashout Code 11
Yellow REAR ANTILOCK Light Flashes 12 Times Fluid Level Switch Grounded During a RABS Stop	See Flashout Code 12
Yellow REAR ANTILOCK Light Flashes 13 Times Speed Processor Check	See Flashout Code 13
Yellow REAR ANTILOCK Light Flashes 14 Times Program Check	See Flashout Code 14
Yellow REAR ANTILOCK Light Flashes 15 Times Memory Failure	See Flashout Code 15
Yellow REAR ANTILOCK Light Flashes 16 Times or More 16 or More Flashes Should Not Occur	See Flashout Code 16

NOTE: Refer to Obtaining the Flashout Code in this Section for procedure to obtain flashout code.

CAUTION: WHEN CHECKING RESISTANCE IN THE RABS SYSTEM, ALWAYS DISCONNECT THE BATTERY. IMPROPER RESISTANCE READINGS MAY OCCUR WITH THE VEHICLE BATTERY CONNECTED.

CH6288-2B

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DIAGNOSIS AND TESTING (Continued)

No Flashout Code

Flashout Code 0

TEST STEP		RESULT ▶	ACTION TO TAKE
0a	NO FLASHOUT CODE BUT RABS LIGHT IS ILLUMINATED		
• There are some faults that illuminate the REAR ANTILOCK light but will not provide a Flashout Code. Refer to Obtaining the Flashout Code in this Section for procedure. Also, be sure to make a good, momentary ground from the diagnostic lead.		No Flashout Code ▶	GO to Test **D2**.

CH6289-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 1 Time This Code Should Not Occur

Flashout Code 1

TEST STEP	RESULT ▶	ACTION TO TAKE
1a NO TEST • This code should not occur. Refer to Obtaining the Flashout Code in this Section for procedures involved in getting the code.	Flashout Code is 1 ▶	If after repeated attempts to take the Flashout Code, Code 1 is still obtained GO to Test E.

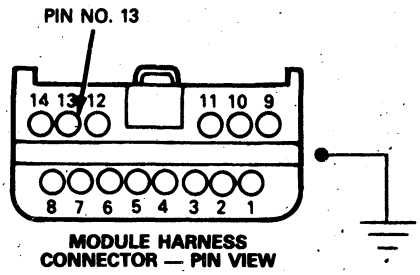
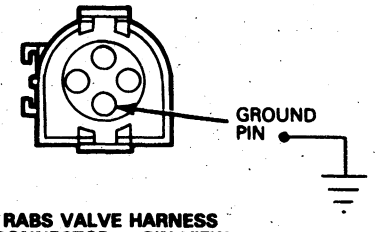
CH6290-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 2 Times (Open Isolate Circuit)

Flashout Code 2

TEST STEP		RESULT ▶	ACTION TO TAKE
2a	CHECK FOR OPEN RABS VALVE ISOLATION SOLENOID WIRING OR MODULE		
1. Turn ignition switch to the OFF position. 2. Disconnect battery. 3. Set the ohmmeter to the 200 ohm scale. 4. Disconnect module harness connector from module. 5. Check for resistance between harness connector Pin 13 and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW		Resistance less than 6 ohms ▶ Resistance over 6 ohms ▶	REPLACE RABS module. GO to **2b**.
2b	CHECK FOR OPEN RABS VALVE GROUND WIRE		
1. Disconnect battery. 2. Disconnect RABS Valve harness connector from valve connector. 3. Set ohmmeter on the 200 ohm scale. 4. Check for resistance between ground pin of valve harness connector and chassis ground.  RABS VALVE HARNESS CONNECTOR — PIN VIEW		Resistance less than 1 ohm ▶ Resistance 1 ohm or more ▶	GO to **2c**. REPAIR open in 397 circuit, isolation solenoid wire. CHECK for dirty or loose connector pins.

CH6291-2B

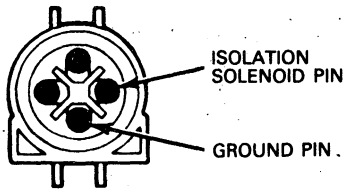
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 2 Times (Open Isolate Circuit) — Continued

Flashout Code 2

TEST STEP		RESULT ▶	ACTION TO TAKE
2c	CHECK FOR OPEN RABS VALVE ISOLATION SOLENOID OR WIRING		
1. Disconnect battery. 2. Set ohmmeter to 200 ohm scale. 3. Check resistance between valve connector isolation solenoid pin and connector ground pin.		Resistance less than 6 ohms ▶	REPAIR open in 599 circuit, isolation solenoid wire from valve to computer module. CHECK for dirty or loose connector pins.
		Resistance over 6 ohms ▶	REPLACE RABS valve.



RABS VALVE CONNECTOR — PIN VIEW

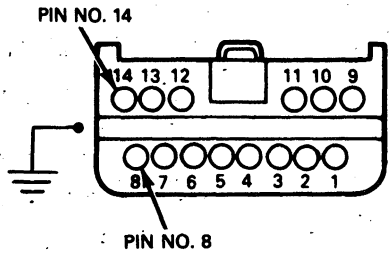
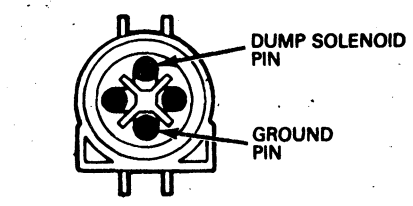
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 3 Times (Open Dump Circuit)

Flashout Code 3

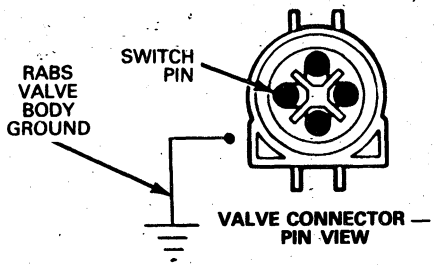
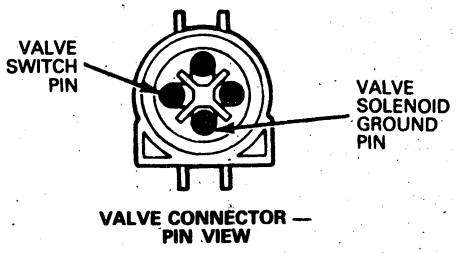
TEST STEP		RESULT ▶	ACTION TO TAKE
3a	CHECK FOR OPEN RABS VALVE DUMP SOLENOID WIRING OR COMPUTER MODULE		
1. Turn ignition switch to the off position. 2. Disconnect the battery. 3. Disconnect module harness connector from module. 4. Place the ohmmeter on the 200 ohm scale. 5. Check resistance between pin 8 (or pin 14) and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW		Resistance less than 3 ohms ▶ Resistance greater than 3 ohms ▶	REPLACE computer module. GO to Test **3b**.
3b	CHECK FOR OPEN RABS VALVE DUMP SOLENOID OR WIRING		
1. Turn the ignition switch to the off position. 2. Disconnect the battery. 3. Disconnect RABS valve harness connector from valve connector. 4. Check resistance between valve connector dump solenoid pin and ground pin.  RABS VALVE CONNECTOR — PIN VIEW		Resistance less than 3 ohms ▶ Resistance greater than 3 ohms ▶	REPAIR open in 664 circuit, dump solenoid wire, from valve to module. CHECK for loose or dirty connector pins. REPLACE RABS valve.

CH6293-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 4 Times Red Brake Warning Light Illuminated RABS Valve Switch Closed	Flashout Code 4

TEST STEP	RESULT	ACTION TO TAKE
4a CHECK FOR CLOSED RABS VALVE SWITCH		
1. Disconnect RABS valve harness connector from valve connector. 2. Place ohmmeter on the 20K scale. 3. Check resistance between valve connector switch pin and valve body.  	Resistance greater than 10K ohms ▶ Resistance less than 10k ohms ▶	GO to Test **4B**. REPLACE RABS valve.
4b CHECK FOR SHORT BETWEEN RABS VALVE SWITCH AND VALVE GROUND LEAD		
1. Set the ohmmeter on the 20K ohm scale. 2. Check resistance between valve connector switch pin and valve solenoid ground pin.  	Resistance greater than 10K ohms ▶ Resistance less than 10K ohms ▶	GO to Test **4C**. REPLACE RABS valve.

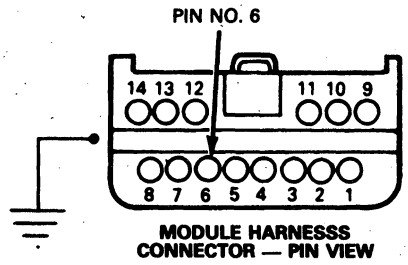
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 4 Times Red Brake Warning Light Illuminated RABS Valve Switch Closed (Continued)	Flashout Code 4

TEST STEP	RESULT ▶	ACTION TO TAKE
4c CHECK FOR RABS VALVE SWITCH WIRE SHORTED TO GROUND OR MODULE		
1. Disconnect battery. 2. Set the ohmmeter on the 200K scale. 3. Disconnect the module harness connector from the module. 4. Check for resistance between harness connector pin 6 and chassis ground.	Resistance greater than 100K ohms ▶	REPLACE computer module.
	Resistance less than 100K ohms ▶	REPAIR short in 535 circuit, valve switch wire from valve to computer module.



MODULE HARNESSS CONNECTOR — PIN VIEW

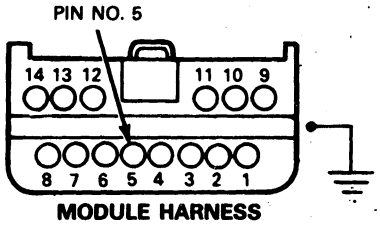
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 5 Times System Dumps Too Many Times in 2WD (2WD and 4WD Vehicles) Condition Occurs While Making Normal or Hard Stops. Rear Brakes May Lock	Flashout Code 5

TEST STEP	RESULT ▶	ACTION TO TAKE
5a		
For 4x2 vehicles or 4x4 vehicles for which the problem was initiated in 4x2 mode		GO to Step **5b**.
For 4x4 vehicles for which the problem was initiated in 4x4 mode only		GO to Step **5c**.
5b CHECK FOR MECHANICAL PROBLEMS IN REAR BRAKE SYSTEM		
1. Disconnect the RABS module harness connector from the module to deactivate the RABS. 2. Drive the vehicle (in 4x2 mode). 3. Make normal stops in a safe area to determine the condition of the rear brake system.	Rear brakes are grabby or tend to lock up easily ▶	REPAIR rear brake system and RETEST.
	Rear brakes are satisfactory for normal braking ▶	REPLACE RABS valve.
5c CHECK FOR MISSING SIGNAL FROM 4 WD SWITCH TO COMPUTER MODULE		
1. Disconnect the RABS module harness from the module. 2. Turn ignition switch on. 3. Shift into 4x4 mode. 4. Set voltmeter to 20 VDC scale. 5. Measure voltage between pin 5 and chassis ground.	Voltage is less than 1 volt ▶	REPLACE RABS valve.
	Voltage is greater than 1 volt ▶	REPAIR 4x4 indicator switch. REFER to the appropriate section in Group 16 for procedures.



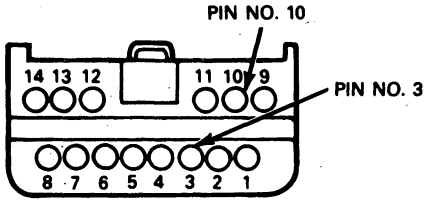
MODULE HARNESS CONNECTOR – PIN VIEW

CH6296-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 6 Times (Sensor Signal Rapidly Cuts In and Out) Condition Only Occurs While Driving	Flashout Code 6

TEST STEP	RESULT	ACTION TO TAKE
6a CHECK FOR ERRATIC SENSOR SIGNAL AND LOOSE WIRE CONNECTIONS		
1. Turn ignition off. 2. Disconnect battery. 3. Set ohmmeter on the 2000 ohm scale. 4. Check resistance between Pin 10 and Pin 3 of the harness connector while shaking the harness from sensor to module.  MODULE HARNESS CONNECTOR – PIN VIEW	Constant reading of 1000 to 2000 ohms ▶ Reading is erratic ▶	GO to Step **6b**. REPAIR loose connection in the 519 or 523 circuits (sensor leads). CHECK for dirty or loose pins, frayed or shorted connectors.
6b CHECK FOR METAL CHIPS ON SENSOR MAGNET POLE PIECE		
• Remove the sensor from the differential and inspect for a build-up of metal chips on sensor magnetic pole.	No metal chips are present ▶ Metal chips are present ▶	GO to Step **6c**. DRAIN and CLEAN differential. CHECK the excitor ring for broken or chipped teeth.
6c CHECK FOR EXCITOR RING DAMAGE		
1. Remove sensor from carrier. 2. Rotate excitor ring and check for damage to teeth.	Teeth are intact and no visible lateral runout is observed ▶ Teeth are damaged or lateral runout of excitor ring is visible ▶	REINSTALL sensor and GO to Test **6d**. REPAIR axle. REFER to the appropriate section in Group 15 for procedure.

CH6297-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 6 Times (Sensor Signal Rapidly Cuts In and Out) Condition Only Occurs While Driving (Cont'd)	Flashout Code 6

TEST STEP		RESULT ▶	ACTION TO TAKE
6d	CHECK FOR ERRATIC OR LOW SENSOR OUTPUT ON COMPUTER MODULE		
1. Locate the sensor test connector. 2. Position vehicle on a hoist and raise the rear wheels to clear the floor. 3. Start the engine and turn the wheels at 5 mph. 4. Place voltmeter on the 2000 mv AC scale. 5. Measure voltage at the two pins of the sensor test connector.  SENSOR TEST CONNECTOR — PIN VIEW		Voltage greater than 650 mV RMS and steady ▶ Voltage less than 650 mV RMS or erratic ▶	REPLACE module. REPLACE sensor and recheck output and replace the sensor test connector cap.

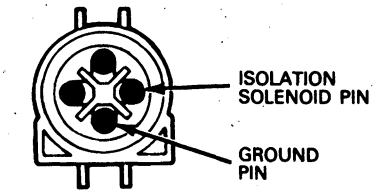
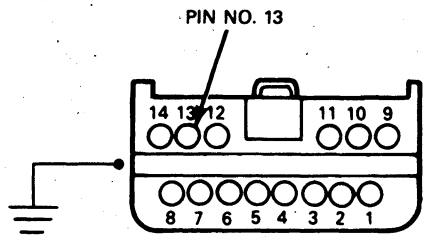
CH6319-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 7 Times No Isolate Valve Self Test

Flashout Code 7

TEST STEP	RESULT	ACTION TO TAKE
7a CHECK FOR RABS VALVE ISOLATION SOLENOID OR WIRING SHORTED TO GROUND		
1. Turn ignition off. 2. Disconnect the valve harness connector from the valve connector. 3. Set the ohmmeter on the 200 ohm scale. 4. Measure the resistance between the valve isolation solenoid pin and the valve ground pin in the valve connector.  VALVE CONNECTOR PIN VIEW	Resistance is greater than 3 ohms ▶ Resistance is less than 3 ohms ▶	GO to Test **7B**. REPLACE RABS valve.
7b CHECK FOR BLOWN INTERNAL FUSE IN THE MODULE		
1. Turn ignition off. 2. Disconnect the battery. 3. Disconnect the valve harness connector from the valve. 4. Disconnect the module harness connector from the module. 5. Place the ohmmeter on the 20K ohm scale. 6. Measure the resistance between module harness connector pin 13 and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Resistance greater than 20K ohms ▶ Resistance less than 20K ohms ▶	REPLACE module. REPAIR short in 599 circuit between RABS valve and module. RECONNECT module and valve.

CH6298-2B

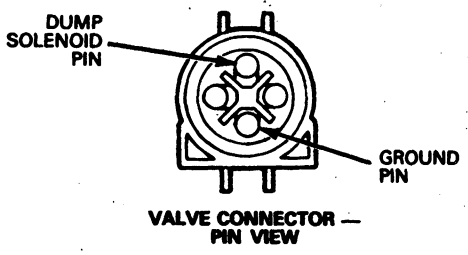
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DIAGNOSIS AND TESTING (Continued)

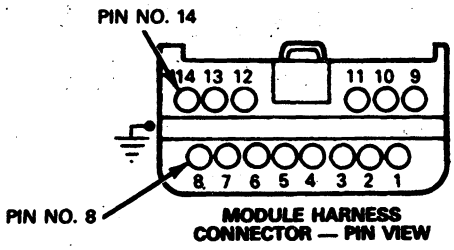
Yellow REAR ANTILOCK Light Flashes 8 Times No Dump Valve Self Test

Flashout Code 8

TEST STEP	RESULT	ACTION TO TAKE
8a CHECK FOR RABS VALVE SOLENOID OR WIRING SHORTED TO GROUND		
1. Turn ignition switch off. 2. Disconnect valve harness connector from valve connector. 3. Set the ohmmeter on the 200 ohm scale. 4. Measure the resistance between the valve dump solenoid pin and the valve ground pin in the valve connector.	Resistance greater than 1 ohm ▶	GO to Test **8b**.
	Resistance is less than 1 ohm ▶	REPLACE RABS valve.
8b CHECK COMPUTER MODULE		
1. Turn ignition off. 2. Disconnect battery. 3. Disconnect valve harness connector from valve connector. 4. Disconnect the module harness connector from the module. 5. Set the ohmmeter on the 20K ohm scale. 6. Measure the resistance between module harness connector pin 8 (or pin 14) and chassis ground.	Resistance greater than 20K ohm ▶	REPLACE module.
	Resistance less than 20K ohm ▶	REPAIR short in 664 circuit between RABS valve and RABS module. RECONNECT module and valve.



VALVE CONNECTOR — PIN VIEW



MODULE HARNESS CONNECTOR — PIN VIEW

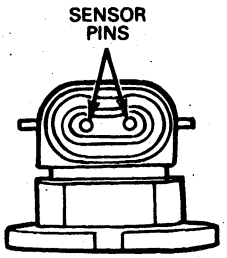
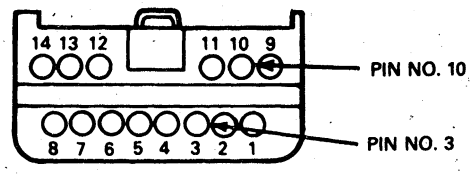
CH6299-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 9 Times High Sensor Resistance

Flashout Code 9

TEST STEP	RESULT ▶	ACTION TO TAKE
9a CHECK FOR OPEN SENSOR OR SENSOR WIRING		
1. Turn key off. 2. Disconnect sensor harness connector from the sensor on the differential. 3. Set the ohmmeter on the 20K ohm scale. 4. Measure the resistance at the two sensor pins.  SENSOR — PIN VIEW	Resistance less than 2500 ohms ▶ Resistance greater than 2500 ohms ▶	GO to Test **9b**. REPLACE sensor.
9b CHECK FOR OPEN SENSOR HARNESS WIRING		
1. Turn key off. 2. Disconnect battery. 3. Reconnect sensor harness connector to sensor. 4. Disconnect module harness connector from module. 5. Set the ohmmeter on the 20K ohm scale. 6. Measure the resistance between harness connector pins 3 and 10.  MODULE HARNESS CONNECTOR — PIN VIEW	Resistance less than 2500 ohms ▶ Resistance greater than 2500 ohms ▶	REPLACE module. REPAIR open in circuits 519 or 523, sensor wires between the sensor and module. CHECK for loose or dirty pin connectors. If defect is found in 14A107 — Jumper Harness (from sensor to left frame rail), REPLACE with original equipment high flex wire.

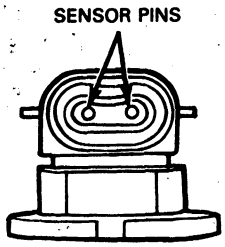
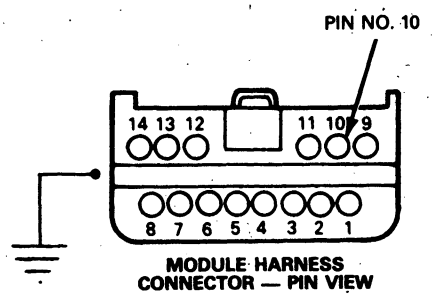
CH6300-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 10 Times Low Sensor Resistance

Flashout Code 10

TEST STEP	RESULT	ACTION TO TAKE
10a CHECK FOR SHORTED SENSOR		
1. Turn ignition off. 2. Disconnect the sensor harness from the sensor. 3. Place the ohmmeter on the 20K ohms scale. 4. Measure the resistance at the two sensor pins.  SENSOR — PIN VIEW	Resistance less than 1000 ohms ▶ Resistance is greater than 1000 ohms ▶	REPLACE sensor. GO to Test **10b**.
10b CHECKING FOR GROUNDED SENSOR WIRING		
1. Turn ignition off. 2. Disconnect the battery. 3. Disconnect the sensor harness connector from the sensor. 4. Disconnect the module harness connector from the module. 5. Set the ohmmeter on the 20K ohm scale. 6. Measure the resistance from pin 10 of the harness connector to chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Resistance less than 20K ohms ▶ Resistance is greater than 20K ohms ▶	REPAIR short to ground in 523 circuit, sensor HI lead to module. CHECK for frayed wires or shorted connectors. If defect is found in the 14A107 Jumper Harness (from sensor to left frame rail), REPLACE with original equipment high flex wire. GO to Test **10c**.

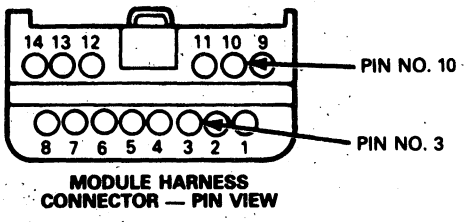
CH6301-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 10 Times Low Sensor Resistance (Continued)

Flashout Code 10

TEST STEP		RESULT ▶	ACTION TO TAKE
10c	CHECK FOR SHORTED SENSOR WIRING		
1. Turn ignition off. 2. Disconnect sensor harness connector from the sensor. 3. Disconnect the module harness connector from the module. 4. Place the ohmmeter on the 20K ohms scale. 5. Measure the resistance from pin 3 to pin 10 of the harness connector.  MODULE HARNESS CONNECTOR — PIN VIEW		Resistance less than 20K ohms ▶	REPAIR short between the 523 and 519 sensor circuits. CHECK for frayed wires or shorted connectors. If defect is found in the 14A107 Jumper Harness (from sensor to left frame rail), REPLACE with original equipment high flex wire.
		Resistance greater than 20K ohms ▶	REPLACE the RABS module.

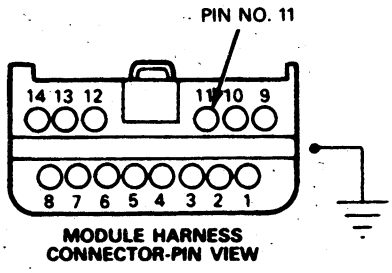
CH6317-2B

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 11 Times. Stop Lamp Switch Always Closed or Stop Lamp Switch Circuit Defective. Condition Indicated Only When Driving Above 35 mph.	Flashout Code 11

TEST STEP	RESULT	ACTION TO TAKE
11a CHECK VEHICLE STOP LIGHTS		
• Apply the service brakes and observe the rear brake lamps.	Lamps illuminate ▶	GO to Test **11b**.
	Lamps do not illuminate ▶	REPAIR or REPLACE vehicle stop light switch. CHECK for blown stop light switch fuse. Investigate reason for blown fuse. CHECK for open stop light switch wiring or blown stop lamps. REPAIR as needed.
11b WIRING FROM MODULE TO BRAKE SWITCH		
• Check for an open between the brake switch and the module: 1. Turn the ignition off. 2. Set the voltmeter on the 20 VDC scale. 3. Remove the module harness connector. 4. Measure the voltage between pin 11 and chassis ground while stepping on the brake pedal.	Voltage is less than 9V ▶	REPAIR the open in the 511 circuit.
	Voltage is 9V or more ▶	CHECK 4 way flasher and directional wiring. This condition could create feedback through the stop light circuit. Also, cruise controls may not operate correctly.



MODULE HARNESS CONNECTOR-PIN VIEW

CH6820-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 12 Times. Red Brake Warning Light Illuminates. Fluid Level Switch Closed During a RABS Stop	Flashout Code 12

TEST STEP	RESULT ▶	ACTION TO TAKE
12a Follow the test procedure outlined in TEST C (but skip test C5).		

CH6821-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 13 Times Speed Processor Check

Flashout Code 13

TEST STEP	RESULT ▶	ACTION TO TAKE
13a NO TEST • RABS module speed circuit phase lock loop failure detected during module self test.	13 flashes are present ▶	REPLACE RABS module.

CH6304-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 14 Times Program Check

Flashout Code 14

TEST STEP	RESULT ▶	ACTION TO TAKE
14a NO TEST • RABS module program check sum failure detected during self test.	If 14 flashes are present ▶	REPLACE RABS module.

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 15 Times Memory Failure

Flashout Code 15

TEST STEP	RESULT ▶	ACTION TO TAKE
15a NO TEST • RABS module RAM failure detected during self test.	If 15 flashes are present ▶	REPLACE RABS module.

CH6306-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 16 Times or More 16 or More Flashes Should Not Occur

Flashout Code 16

TEST STEP	RESULT ▶	ACTION TO TAKE
16a NO TEST • This code should not occur. Refer to obtaining the Flashout Code in this Section for procedures involved in getting the code.	Flashout Code is 16 ▶	If after repeated attempts to take the Flashout Code, Code 16 is still obtained, REPLACE RABS module.

CH6307-2A

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DISASSEMBLY AND ASSEMBLY

The RABS module, valve and sensor are serviced as assemblies and are not to be disassembled. The excitor ring is pressed on the differential case and, if removed for any reason, must be discarded.

REMOVAL AND INSTALLATION

Fuses

Three replaceable fuses are involved with the RABS. The fuses are located in the fuse box. A 20 amp fuse protects the total RABS. A 15 amp fuse protects the red BRAKE and yellow REAR ANTILOCK warning lights. Another 15 amp fuse protects the four-way stop lamp cluster. Refer to Section 34-31, Fuses, Circuit Breakers and Fuse Links.

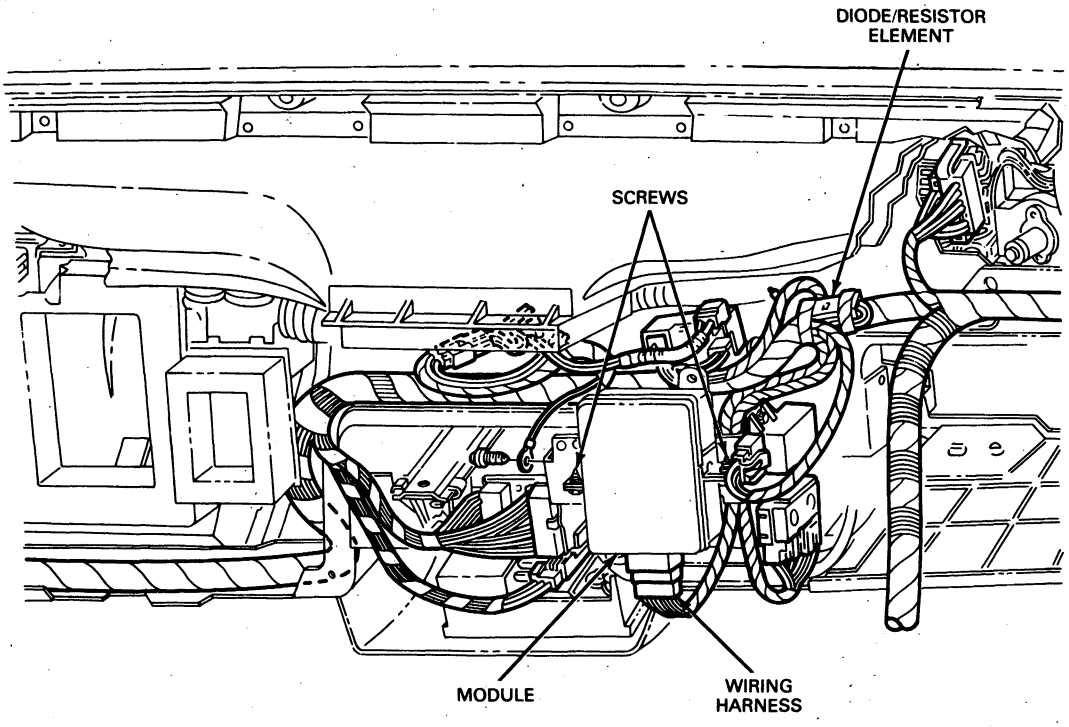
RABS Module

Removal

1. Disconnect the wiring harness from the RABS module by depressing the plastic tab on the connector and pulling the connector off.
2. Remove the two screws that retain the module to the dash panel. Remove the module.

Installation

1. Place the module in position on the dash panel. Install and tighten the two retaining screws.
2. Connect the wiring harness to the module.
3. Check the system for proper operation.



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REMOVAL AND INSTALLATION (Continued)

RABS Valve

Removal

1. Disconnect and plug the two brake lines connected to the RABS valve.
2. Disconnect the wiring harness to the valve.
3. Remove the three nuts retaining the valve to the frame rail and remove the valve.

Installation

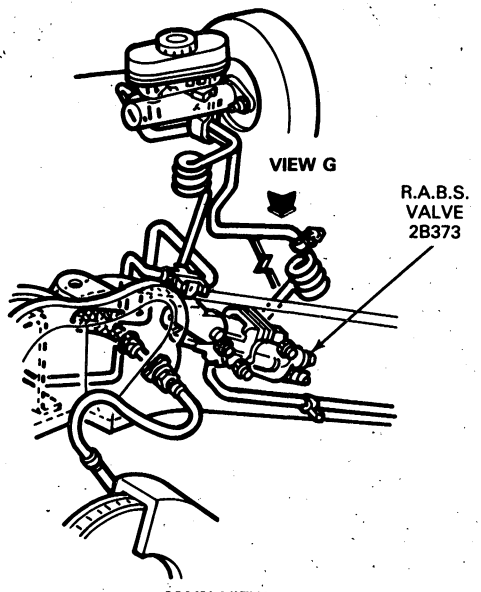
1. Position the RABS valve on the frame rail. Install the three nuts and tighten to 17-23 N·m (12-17 ft-lb).
2. Connect the brake valve wiring harness connector.
3. Connect the brake lines to the valve and tighten as follows:

   1/2-20 threaded fitting use 14-23 N·m (10-17 ft-lb)

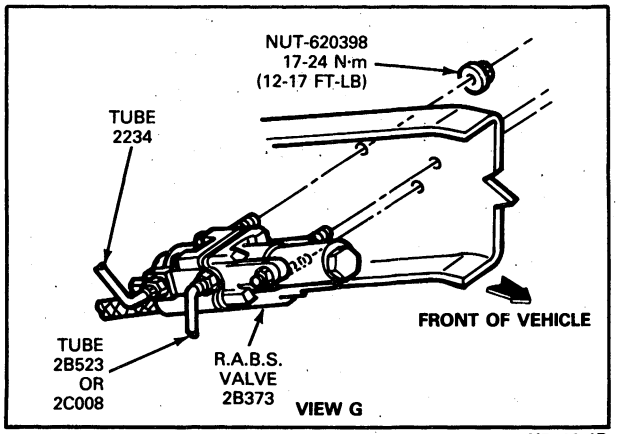
   7/16-24 threaded fitting use 14-20 N·m (10-15 ft-lb)

CAUTION: Do not overtighten the fittings.

4. Bleed the brake system as described in Section 12-01, General Hydraulic Brake Service. It is not necessary to energize the valve electrically to bleed the rear brakes.



MAIN VIEW



H5412-1B

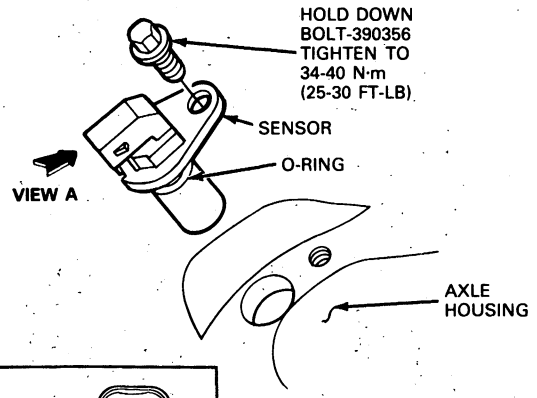
RABS Sensor

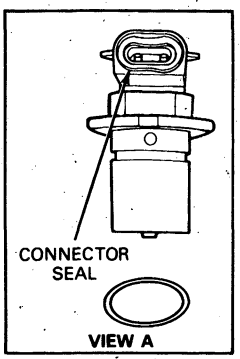
Removal

1. Pull the wiring harness connector off.
2. Remove the sensor hold down bolt and remove the sensor from the axle housing.

Installation

1. Clean the axle mounting surface. Use care to prevent dirt from entering the axle housing.
2. Inspect and clean the magnetized sensor pole piece to ensure that it is free from loose metal particles which could cause erratic system operation. Inspect the sensor O-ring for damage and replace if necessary.
3. Lightly lubricate the sensor O-ring with motor oil, align the sensor bolt hole, and install. Do not apply force to the plastic sensor connector. The sensor flange should slide to the mounting surface. This will insure the air gap setting is between 0.005 and 0.045 inches.
4. Install the hold down bolt and tighten to 34-40 N·m (25-30 ft-lb).
5. Inspect the blue sensor connector seal and replace if missing or damaged. Push the connector on the sensor.





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REMOVAL AND INSTALLATION (Continued)

Excitor Ring

Inspection

1. Remove the sensor as described above.
2. View the excitor ring teeth through the sensor hole. Rotate the rear axle and check the excitor ring teeth for damage or breakage. Dented or broken teeth could cause the RABS system to function when not required.

Removal

To service the excitor ring, the differential case must be removed from the axle housing, and the excitor ring pressed off the case. UPON REMOVAL, THE EXCITOR RING IS TO BE DISCARDED. IT IS NOT TO BE REUSED. For service procedures, refer to the appropriate Axle Section in Group 15.

SPECIFICATIONS

ROTUNDA EQUIPMENT

Number	Description
059-00004	Digital Volt-Ohm Meter

CH5821-1B

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SECTION 12-50 Vacuum Brake Booster—Single Diaphragm—Dash-Mounted (Bendix)

SUBJECT	PAGE
ADJUSTMENTS	
Push Rod Adjustment	12-50-1
DESCRIPTION	12-50-1
DIAGNOSIS AND TESTING	12-50-1
REMOVAL AND INSTALLATION	
Vacuum Booster	12-50-2
REMOVAL AND INSTALLATION (Cont'd)	
Vacuum Booster (Cont'd)	
E-150	12-50-3
F-150, F-250 and Bronco	12-50-2
SPECIFICATIONS	12-50-5
VEHICLE APPLICATION	12-50-1

VEHICLE APPLICATION

F-150 through F-250 (4x2), E-150, F-150 through F-250 (4x4) and Bronco.

DESCRIPTION

Service information (vacuum boosters only) is given in this Section. Adjustments and repairs for the hydraulic brake systems are given in Sections 12-01, General Hydraulic Brake Service 12-02, Drum Brakes—Single Cylinder, Dual Piston and 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper.

The single diaphragm vacuum booster is a self-contained vacuum hydraulic power braking unit. It is a vacuum-suspended unit that uses engine manifold vacuum and atmospheric pressure for its power. The booster (Fig. 1) consists of three basic elements combined into a single unit.

The three basic elements are:

1. A vacuum power chamber consisting of a front and a rear shell, diaphragm, diaphragm plate, hydraulic push rod, and vacuum diaphragm return spring.
2. A mechanically actuated booster check valve, integral with the vacuum power diaphragm, which controls the degree of power brake application and release in accordance with foot pressure applied to the valve operating rod through the brake pedal linkage.
3. A hydraulic dual master cylinder which supplies hydraulic pressure to the brake system.

The Bendix single diaphragm, dash-mounted-booster is not repairable and booster must be replaced as a unit. The booster check valve is the only component which can be serviced on the booster assembly.

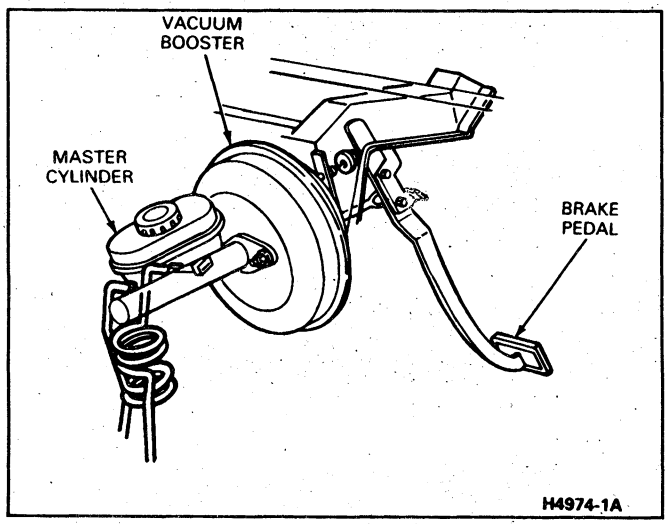


FIG. 1 Booster and Dual Master Cylinder—Typical

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures.

ADJUSTMENTS

Push Rod Adjustment

The push rod has an adjustment screw to maintain the correct relationship between the booster control valve plunger and the master cylinder piston. If the plunger is too long it will prevent the master cylinder piston from completely releasing hydraulic pressure,

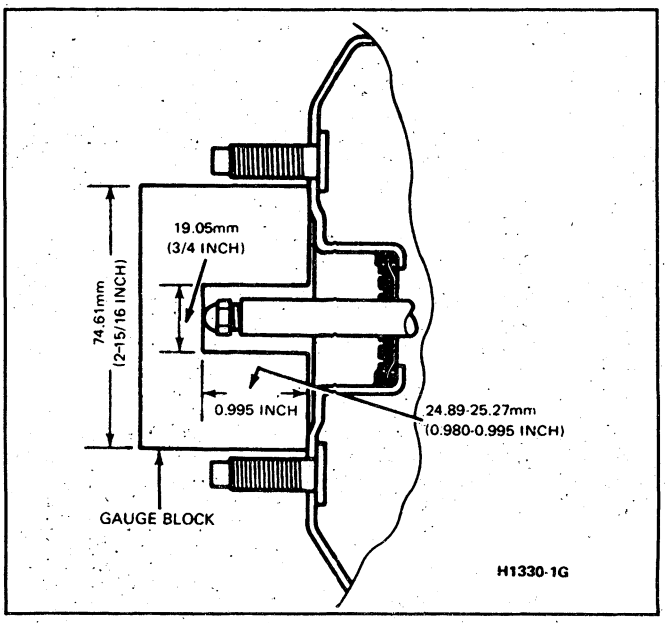


FIG. 2 Booster Push Rod Gauge Dimensions and Adjustment

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causing the brakes to drag. If the plunger is too short it will cause excessive pedal travel and an undesirable clunk in the booster area. Remove the master cylinder for access to the booster push rod.

To check the adjustment of the screw, fabricate a gauge and place it against the master cylinder mounting surface of the booster body as shown in Fig. 2. Adjust the push rod screw by turning it until the end of the screw just touches the inner edge of the slot in the gauge.

REMOVAL AND INSTALLATION

Vacuum Booster

F-150, F-250 and Bronco

Refer to Figs. 3 and 4.

NOTE: Make sure that the booster rubber reaction disc is properly installed as shown in Fig. 5 if the master cylinder push rod is removed or accidentally pulled out, a dislodged disc may cause excessive pedal travel and extreme operation sensitivity. The disc is black compared to the silver colored valve plunger that will be exposed after the push rod and front seal are removed. The booster unit is serviced as an assembly and must be replaced if the reaction disc cannot be properly installed and aligned, or if it cannot be located within the unit itself.

Removal

1. Disconnect the stop lamp switch wiring to prevent running the battery down.
2. Support the master cylinder from the underside with a prop.
3. Loosen the clamp that secures the manifold vacuum hose to the booster check valve, and remove the hose (Fig. 4). Remove the booster check valve.
4. Remove the master cylinder-to-booster retaining nuts.
5. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
6. From inside the cab, remove the cotter pin and slide the stop lamp switch, spacers and bushing off the brake pedal arm.
7. From inside the cab, remove the nuts retaining the booster to the dash. Remove the booster from the engine compartment.

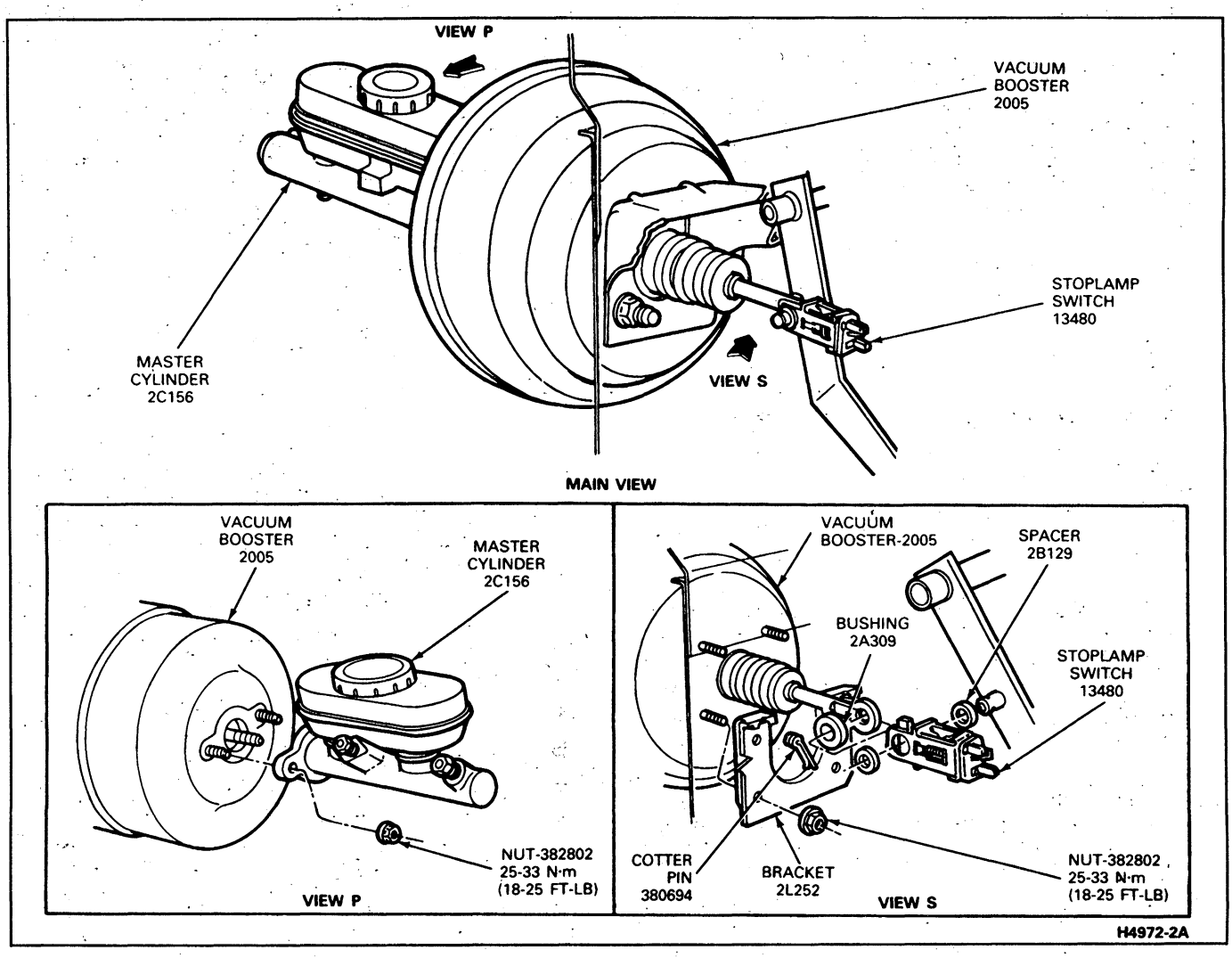


FIG. 3 Brake Booster Installation—F-150, F-250 and Bronco

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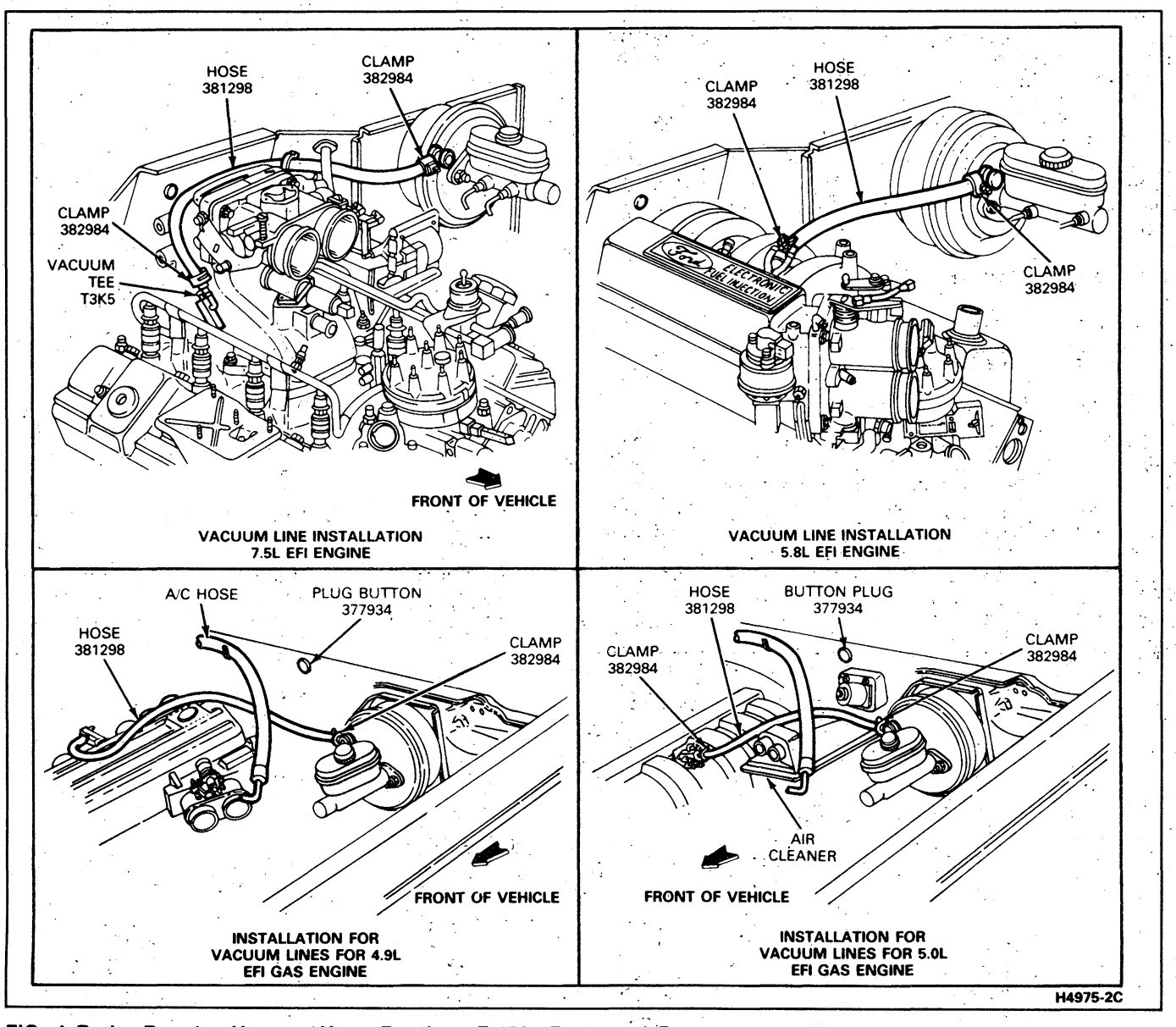


FIG. 4 Brake Booster Vacuum Hose Routing—F-150—F-250 and Bronco

Installation

1. Mount the booster assembly on the engine side of the dash panel by sliding the bracket mounting bolts and valve operating rod in through the holes in the dash panel.

   NOTE: Make certain that the booster push rod is positioned on the correct side of the master cylinder to install onto the push pin prior to tightening the booster assembly to the dash.

2. From inside the cab, install the booster mounting bracket-to-dash panel retaining nuts. Tighten nuts to 18-33 N·m (13-25 ft-lb).

3. Position the master cylinder on the booster assembly, install the retaining nuts, and remove the prop from underneath the master cylinder. Tighten nuts to 18-33 N·m (13-25 ft-lb).

4. Install the booster check valve. Connect the manifold vacuum hose to the booster check valve and secure with the clamp. Make sure the vacuum hose is routed as shown in Fig. 4.

5. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm, along with spacers on each side, and secure with the cotter pin.

6. Connect the stop lamp switch wiring.

7. Start the engine and check brake operation.

Vacuum Booster

E-150

Refer to Figs. 6 and 7.

NOTE: Make sure that the booster rubber reaction disc is properly installed as shown in Fig. 5. If the master cylinder push rod is removed or accidentally pulled out, a dislodged disc may cause excessive pedal travel and extreme operation sensitivity. The disc is black compared to the silver colored plunger that will be exposed after the push rod and front seal is removed. The booster unit is serviced as an assembly and must be replaced if the reaction disc cannot be properly

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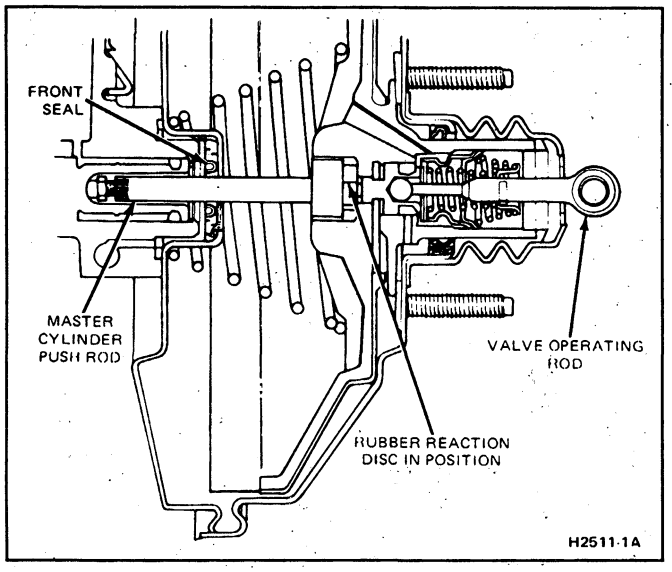


FIG. 5 Checking Reaction Disc Installation—Single Diaphragm 11 Inch Vacuum Booster

installed and aligned, or if it cannot be located within the unit itself.

Removal

1. Disconnect the stop lamp switch to prevent running the battery down.
2. Support the master cylinder from the underside with a prop.
3. Loosen the clamp that secures the vacuum hose to the booster check valve and remove the hose (Fig. 7). Remove the booster check valve.
4. Remove the nuts retaining the clutch master cylinder and retainer to the booster. Remove and position the clutch master cylinder and retainer so fluid does not spill out of the cylinder. Note that the two lower holes on the retainer are used for installation purposes.
5. Remove the master cylinder to booster retaining nuts.
6. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
7. From inside the cab, remove the cotter pin and slide the stop lamp switch, spacers and bushing off the brake pedal arm.
8. From inside the cab, remove the nuts retaining the booster to the bracket. Remove the booster from the engine compartment.

Installation

1. Mount the booster assembly on the engine side of the dash panel by sliding the bracket mounting bolts and valve operating rod in through the holes in the dash panel.

   NOTE: Make sure that the booster push rod is positioned on the correct side of the master cylinder to install onto the push pin prior to tightening the booster assembly to the dash.
2. From inside the cab, install the booster mounting bracket-to-dash panel retaining nuts. Tighten the nuts to 13-25 N·m (10-18 ft-lbs).
3. Position the master cylinder on the booster assembly, install the retaining nuts and remove the prop from underneath the master cylinder. Tighten the nuts to 13-25 N·m (10-18 ft-lb).

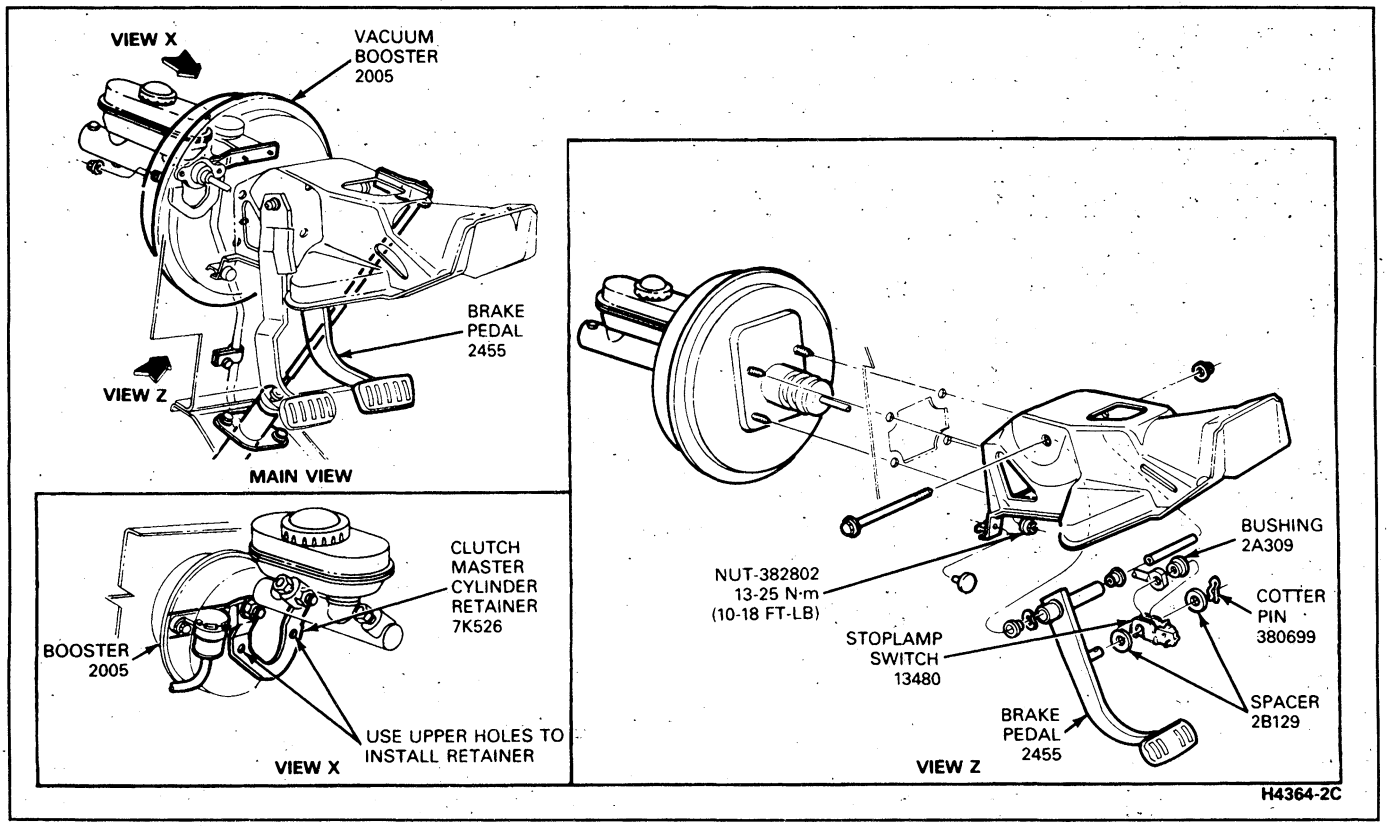


FIG. 6 Brake Booster Installation—E-150

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4. Position the two lower holes of the retainer and clutch master cylinder over the studs and nuts. Install the nuts and tighten to 13-25 N·m (10-18 ft-lb).
5. Install the booster check valve. Connect the vacuum hose to the booster check valve and secure with a clamp. Make sure the vacuum hose is routed as shown in Fig. 7.
6. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm along with spacers on each side and secure the assembly with the cotter pin.
7. Connect the stop lamp switch.
8. Start the engine and check brake operation.

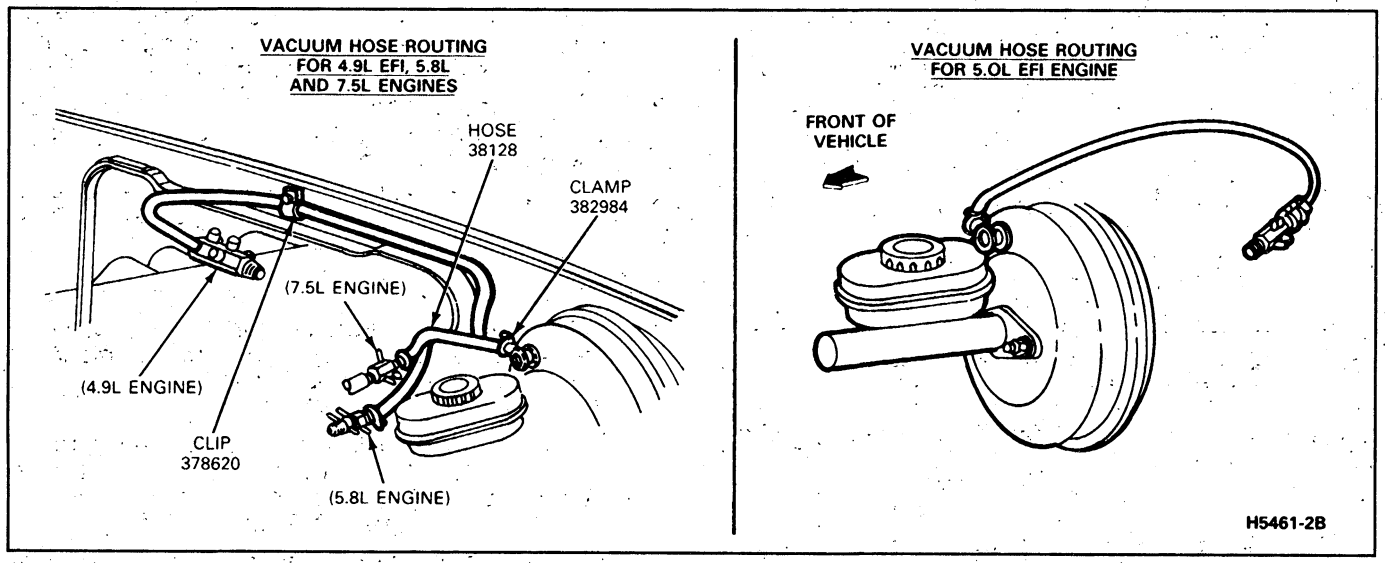


FIG. 7 Brake Booster Vacuum Hose Routing—E-150

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Application	Torque Range	
		N·m	Ft-Lbs
Master Cylinder to Booster	E-150	13-25	10-18
Master Cylinder to Booster	F-150, F-250, Bronco	18-33	13-25
Booster to Dash Panel	E-150	13-25	10-18
Booster to Dash Panel	F-150, F-250, Bronco	18-33	12-25
Clutch Master Cylinder Retainer to Booster	E-150	13-25	10-18

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SECTION 12-52 Vacuum Brake Booster—Tandem Diaphragm—Dash-Mounted (Bendix)

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION	
Push Rod	12-52-1	Vacuum Booster	12-52-1
DESCRIPTION	12-52-1	SPECIFICATIONS	12-52-5
DIAGNOSIS AND TESTING	12-52-1	VEHICLE APPLICATION	12-52-1

VEHICLE APPLICATION

E-250-E-350 and F-250-F-350 (4x2 and 4x4) Vehicles

DESCRIPTION

Service information for only the vacuum booster is given in this Section. Adjustments and repairs for the hydraulic brake-system are given in Sections 12-01, General Hydraulic Brake Service, 12-02 Drum Brakes—Single Cylinder, Dual Piston, and 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

The tandem diaphragm vacuum booster, is a self-contained vacuum hydraulic power braking unit. It is a vacuum suspended unit that uses engine manifold vacuum and atmospheric pressure for its power. The booster consists of three basic elements combined into a single unit.

The three basic elements are:

1. A vacuum power chamber consisting of a front and a rear shell, center plate, front and a rear diaphragm, hydraulic push rod, and vacuum diaphragm return spring.
2. A mechanically actuated booster check valve, integral with the vacuum power diaphragms, which controls the degree of power brake application and release in accordance with the foot pressure applied to the valve operating rod throughout the brake pedal linkage.
3. A hydraulic dual master cylinder which supplies hydraulic pressure to the brake system.

The Bendix tandem diaphragm, dash-mounted booster is not repairable and must be replaced as a unit.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures.

ADJUSTMENTS

Push Rod

The push rod has an adjustment screw to maintain the correct relationship between the booster control valve plunger and the master cylinder piston. If the plunger is too long it will prevent the master cylinder piston from completely releasing hydraulic pressure, causing the brakes to drag. If the plunger is too short it will cause excessive pedal travel and an undesirable clunk in the booster area. Remove the master cylinder for access to the booster push rod.

To check the adjustment of the screw, fabricate a gauge and place it against the master cylinder mounting surface of the booster body as shown in (Fig. 1). Adjust the push rod screw by turning it until the end of the screw just touches the inner edge of the slot in the gauge.

REMOVAL AND INSTALLATION

Vacuum Booster

F-250, F-350

Refer to Figs. 2 and 3.

Removal

1. Disconnect the stop lamp switch wiring to prevent running the battery down.
2. Support the master cylinder from the underside with a prop.

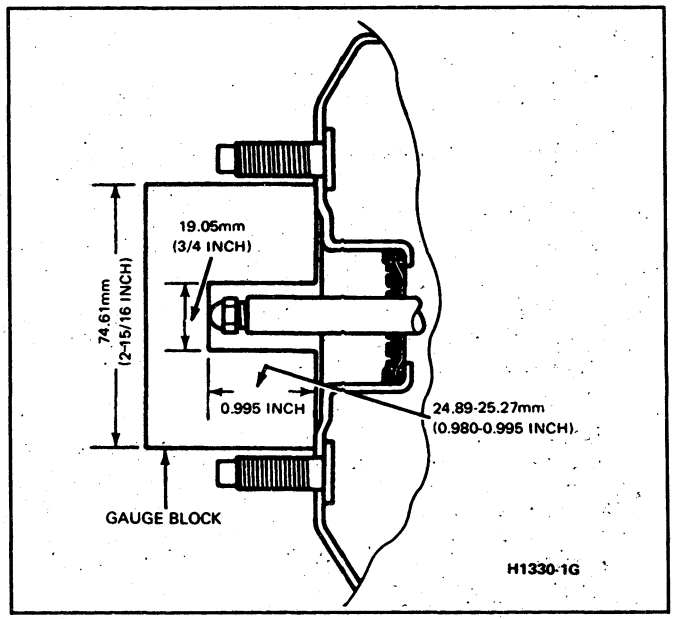


FIG. 1 Bendix Booster Push Rod Gauge Dimensions and Adjustments—E-250—E-350 and F-250—F-350

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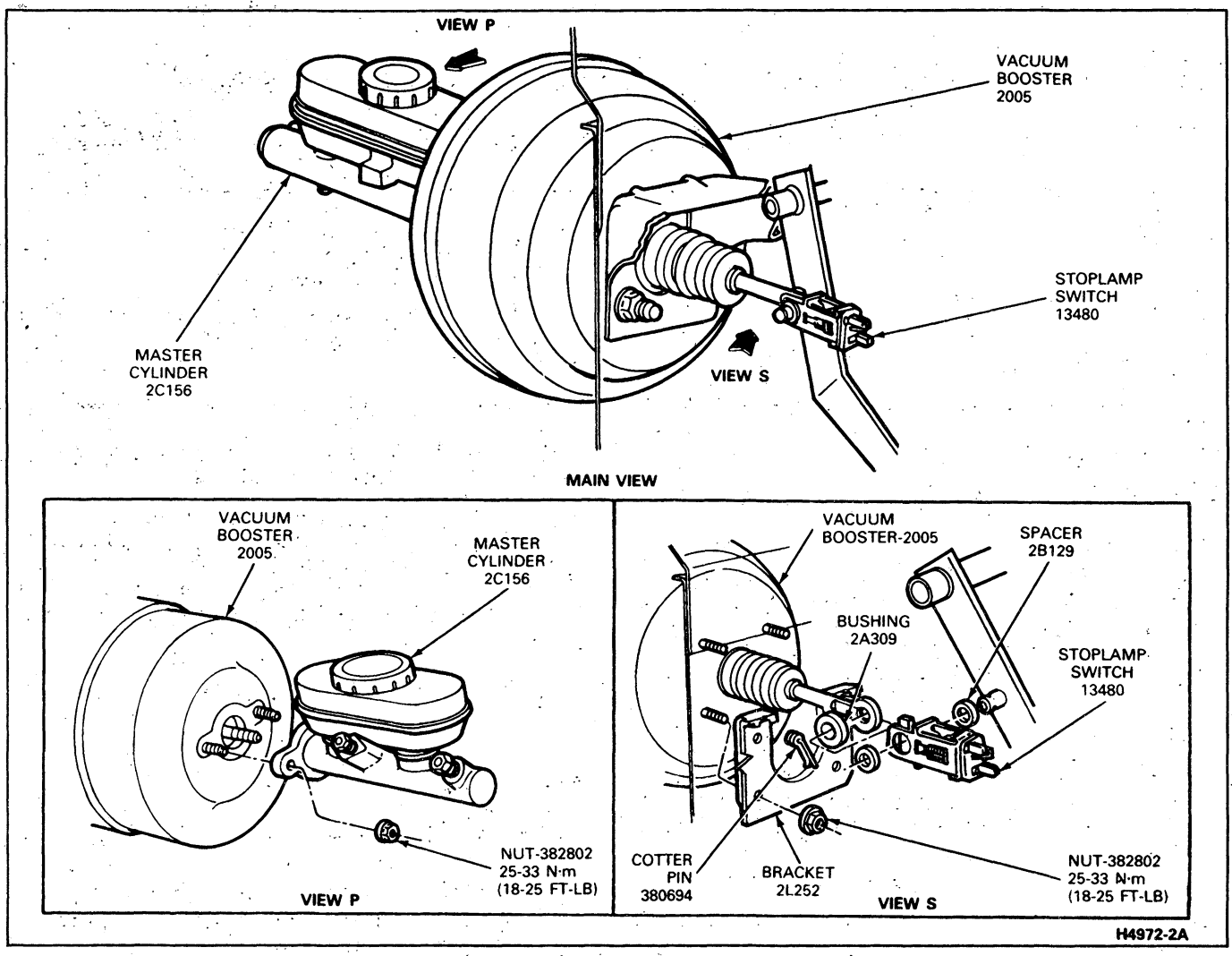


FIG. 2 Brake Booster Installation F-250 and F-350

3. Loosen the clamp that secures the manifold vacuum hose to the booster, and remove the hose (Fig. 3).
4. Remove the wraparound clip from the booster inboard stud.
5. Remove the master cylinder-to-booster retaining nuts.
6. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
7. From inside the cab, remove the cotter pin and slide the stop lamp switch, push rod, spacers and bushing off the brake pedal arm.
8. From inside the cab, remove the nuts retaining the booster to the dash. Remove the booster from the engine compartment.

Installation

1. Mount the booster and bracket assembly on the engine side of the dash panel by sliding the valve operating rod in through the holes in the dash panel and securing it with nuts from engine compartment. Tighten the nuts to 18-33 N·m (13-25 ft-lb).
2. Position the master cylinder on the booster assembly, install the retaining nuts, and remove the prop from underneath the master cylinder. Tighten the nuts to 18-33 N·m (13-25 ft-lbs).
3. Install the wraparound clip on the booster inboard stud.
4. Connect the manifold vacuum hose to the booster and secure with the clamp. Make sure the hose is routed as shown in Fig. 3.
5. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm, along with spacers on each side and secure with the cotter pin.
6. Connect the stop lamp switch wiring.
7. Start the engine and check brake operation.

Vacuum Booster

E-250, E-350

Refer to Figs. 4 and 5.

Removal

1. Disconnect the stop lamp switch to prevent running the battery down.

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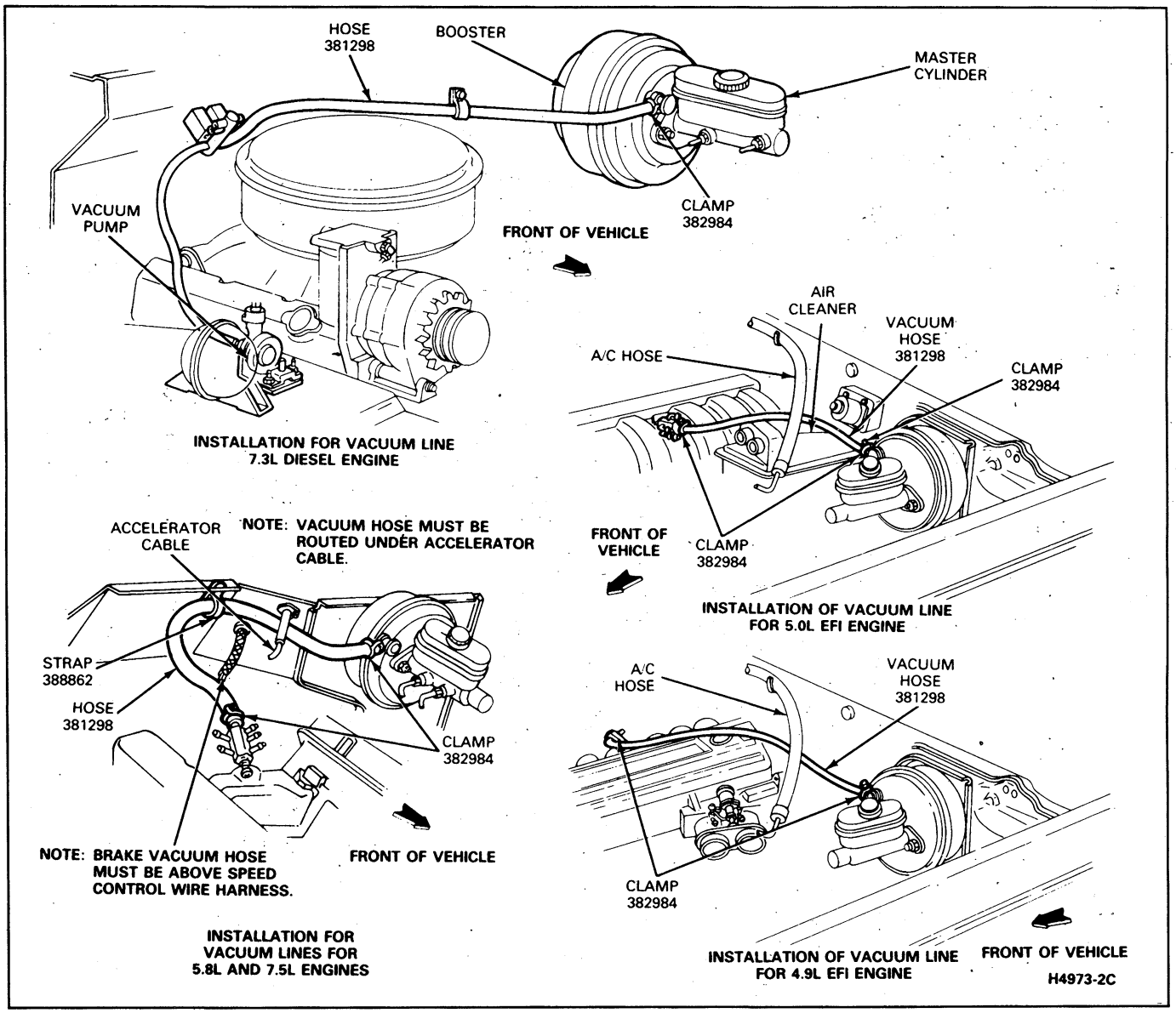


FIG. 3 Brake Booster Vacuum Hose Routing F-250 and F-350

2. Support the master cylinder from the underside with a prop.
3. Loosen the clamp that secures the vacuum hose to the booster check valve and remove the hose (Fig. 5). Remove the booster check valve.
4. Remove the nuts retaining the clutch master cylinder and retainer to the booster. Remove and position the clutch master cylinder and retainer so fluid does not spill out of the cylinder. Note that the two upper holes on the retainer are used for installation purposes.
5. Remove the master cylinder to booster retaining nuts.
6. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
7. From inside the cab, remove the cotter pin and slide the stop lamp switch, spacers and bushing off the brake pedal arm.
8. From inside the cab, remove the nuts retaining the booster to the bracket. Remove the booster from the engine compartment.

Installation

1. Mount the booster assembly on the engine side of the dash panel by sliding the bracket mounting bolts and valve operating rod in through the holes in the dash panel.

   NOTE: Make sure that the booster push rod is positioned on the correct side of the master cylinder to install onto the push pin prior to tightening the booster assembly to the dash.
2. From inside the cab, install the booster mounting bracket-to-dash panel retaining nuts. Tighten the nuts to 13-25 N·m (10-18 ft-lb).

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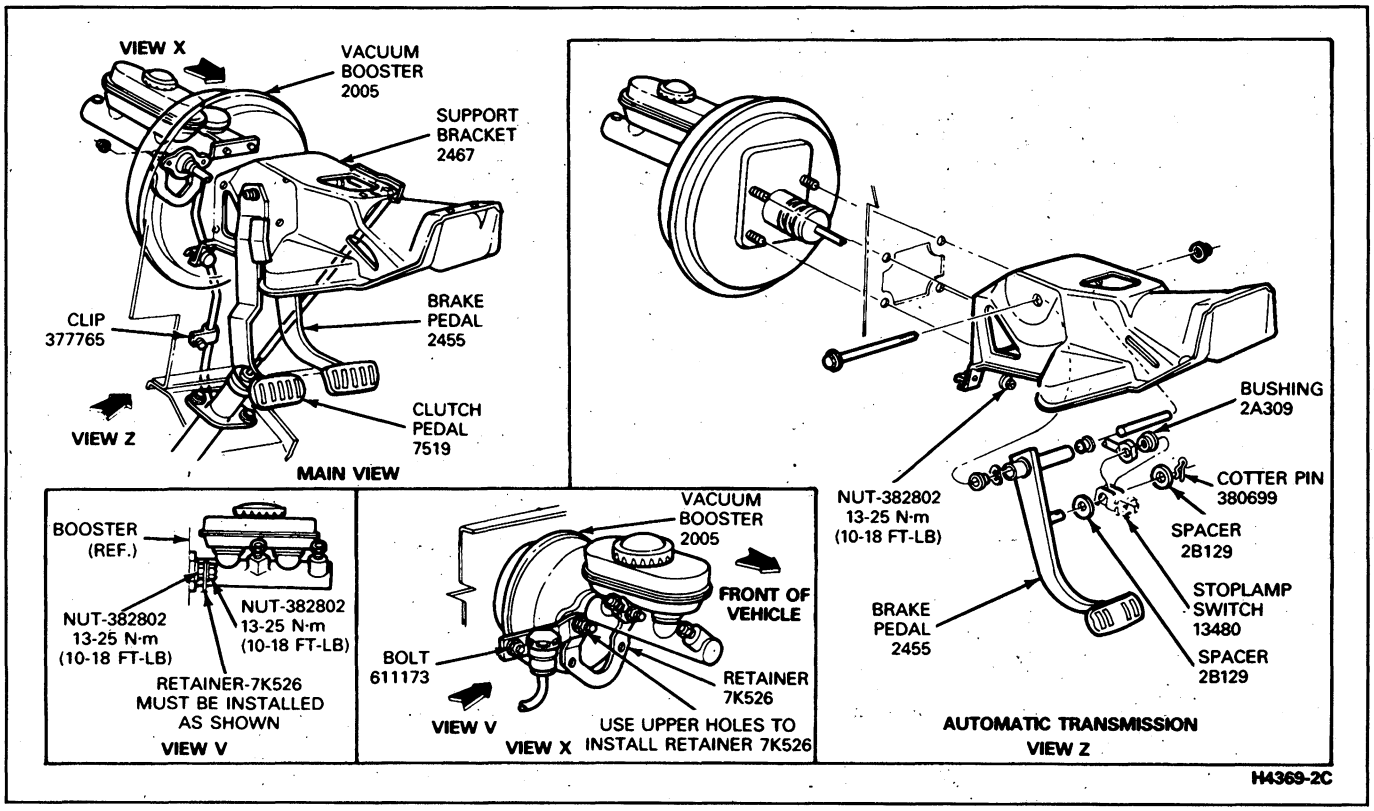


FIG. 4 Brake Booster Installation E-250 and E-350

3. Position the master cylinder on the booster assembly, install the retaining nuts and remove the prop from underneath the master cylinder. Tighten the nuts to 13-25 N·m (10-18 ft-lb).
4. Position the two upper holes of the retainer and clutch master cylinder over the studs and nuts. Install the nuts and tighten to 13-25 N·m (10-18 ft-lb).
5. Install the booster check valve. Connect the vacuum hose to the booster check valve and secure with a clamp. Make sure the vacuum hose is routed as shown in Fig. 5.
6. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm along with spacers on each side and secure the assembly with the cotter pin.
7. Connect the stop lamp switch.
8. Start the engine and check brake operation.

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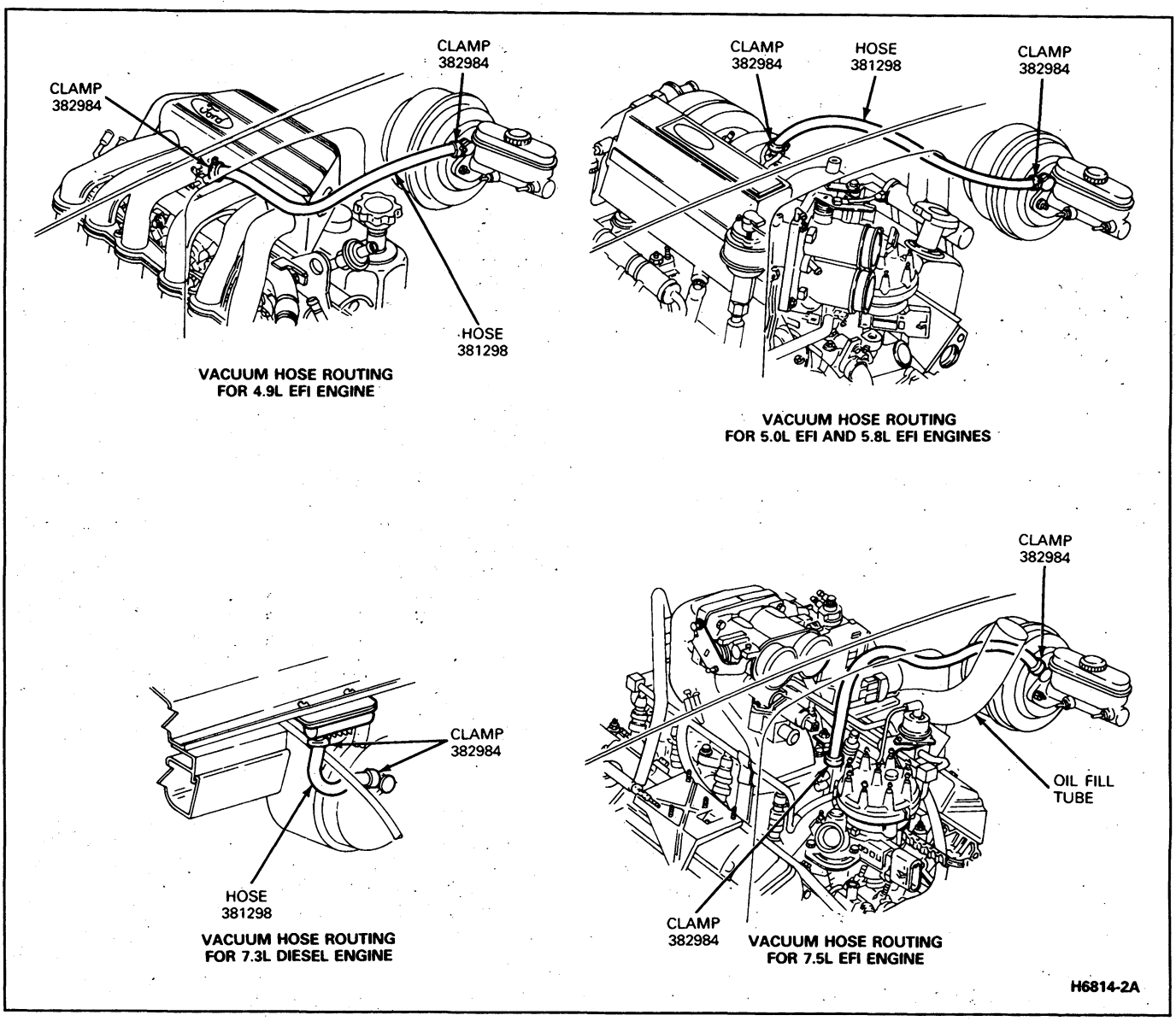


FIG. 5 Brake Booster Vacuum Hose Routing E-250 and E-350

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Application	Torque Range	
		N•m	Ft-Lbs
Master Cylinder to Booster	E-250, E-350	13-25	10-18
Master Cylinder to Booster	F-250, F-350	18-33	13-25
Booster to Dash Panel	E-250, E-350	13-25	10-18
Booster to Dash Panel	F-250, F-350	18-33	12-25
Clutch Master Cylinder Retainer to Booster	E-250, E-350	13-25	10-18

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SECTION 12-56 Brake Booster Vacuum Pump—7.3L Diesel Engine

SUBJECT	PAGE
ADJUSTMENTS	
Vacuum Pump Belt Tension	12-56-1
DESCRIPTION	12-56-1
DIAGNOSIS AND TESTING	12-56-1
REMOVAL AND INSTALLATION	
Low Vacuum Indicator Switch	12-56-1
REMOVAL AND INSTALLATION (Cont'd)	
Vacuum Pump	12-56-1
SPECIFICATIONS	12-56-7
VEHICLE APPLICATION	12-56-1

VEHICLE APPLICATION

E-250—E-350 and F-250—F-350 Equipped w/ 7.3L Diesel Engine.

DESCRIPTION

On gasoline engine vehicles, engine vacuum is used to power the vacuum booster brake. On diesel engines, however, insufficient vacuum is available for vacuum booster brake operation.

On diesel engine vehicles, vacuum is supplied from a pump located on the top right side of the engine (Fig. 1). The diesel engine vacuum pump is driven by a single belt off the alternator (Fig. 2).

Diesel engine equipped vehicles employ the use of a low-vacuum indicator switch which actuates the BRAKE warning lamp when vacuum is beneath a specified level (Fig. 1). The switch senses vacuum through a fitting in the vacuum manifold that intercepts the vacuum flow from the pump.

The low-vacuum switch for E-250—E-350 models is mounted to the left side fender panel. On F-250—F-350 models the switch is located on the right side of the engine compartment adjacent to the vacuum pump.

The vacuum pump, low-vacuum indicator switch and connecting hoses are shown in Fig. 1.

Service information (Brake Booster Vacuum Pump—7.3L Diesel Engines) is given here. Adjustments and repairs for the hydraulic brake systems are given in Sections 12-01, General Hydraulic Brake Service; 12-02, Drum Brakes—Single Cylinder, Dual Piston; and 12-20, Disc Brakes—Single Piston—Sliding Caliper.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures other than those listed in the chart.

ADJUSTMENTS

Vacuum Pump Belt Tension

Refer to Figs. 2 and 3.

NOTE: When tightening all drive belts, refer to the sequence described in Section 27-06, Accessory Drive Belt Service.

1. Loosen the vacuum pump adjustment bolt and the pivot bolt.
2. Insert a 3/8 inch drive breaker bar or ratchet in the adjustment plate slot. Lift up on the assembly until the specified tension is obtained. Measure the tension with Belt Tension Gauge, T63L-8620-A, or equivalent. (For belt tension specifications, refer to Specifications at the end of this Section.)
3. With tension still applied, tighten the adjustment bolt and the pivot bolt to 15-25 N·m (11-18 ft-lbs).

REMOVAL AND INSTALLATION

Low Vacuum Indicator Switch

Refer to Fig. 1.

NOTE: The low vacuum switch for E-250—E-350 models is mounted to the left side fender panel. On F-250—F-350 models the switch is located on the right side of the engine compartment adjacent to the vacuum pump.

Removal

1. Disconnect vacuum hose from low-vacuum indicator switch.
2. Remove two attaching screws and remove switch and bracket assembly.

Installation

1. Position switch and bracket assembly to panel and secure with two screws. Tighten screws to 8-11 N·m (5.8-7.5 ft-lbs).
2. Connect vacuum hose to low vacuum indicator switch.

Vacuum Pump

Refer to Fig. 3.

Removal

1. Remove the hose clamp and disconnect the pump from the hose on the manifold vacuum outlet fitting (Fig. 1).
2. Loosen the vacuum pump adjustment bolt and the pivot bolt. Slide the pump downward and remove the drive belt from the pulley.
3. Remove the pivot and adjustment bolts and the bolts retaining the pump to the adjustment plate. Remove the vacuum pump and adjustment plate.

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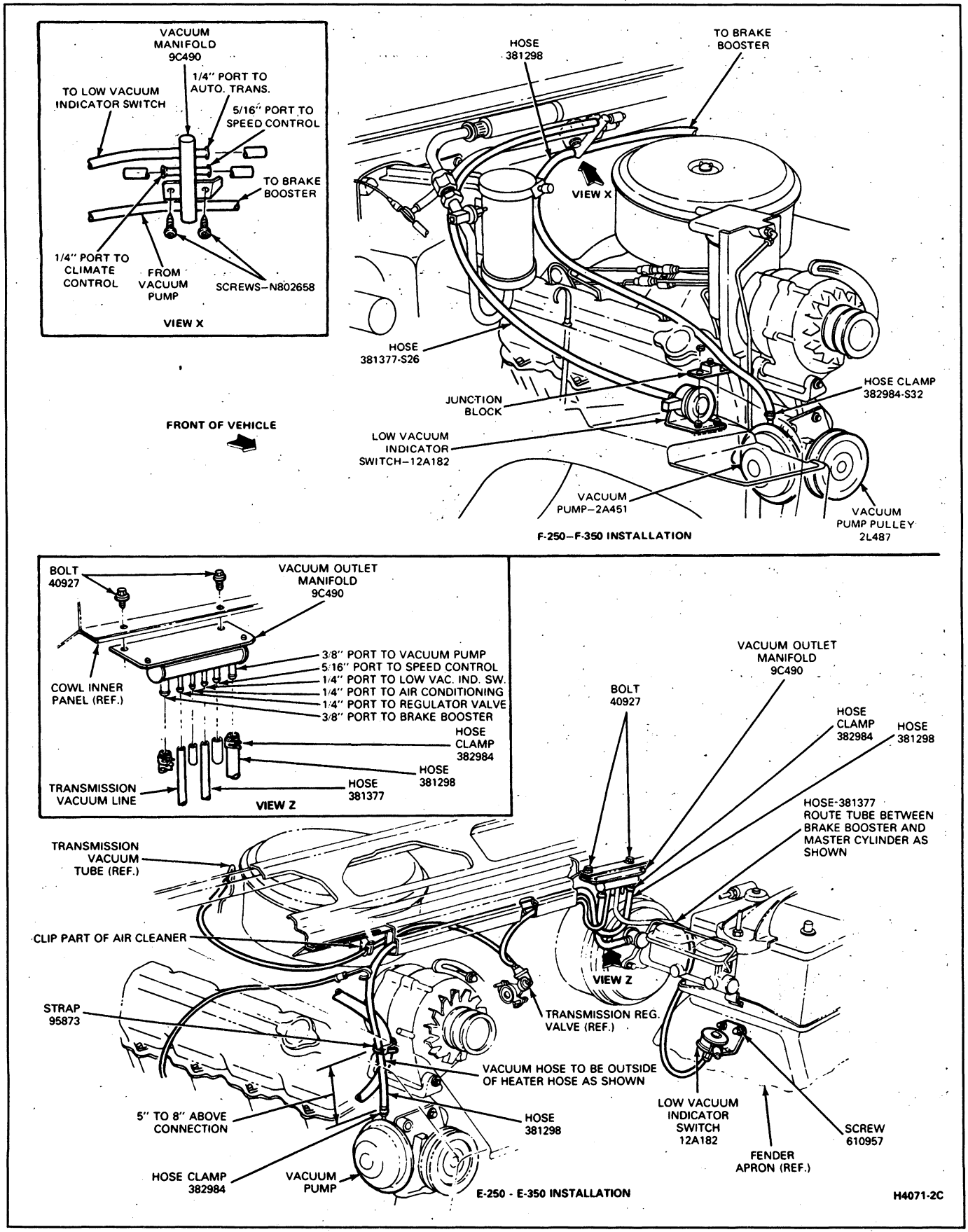
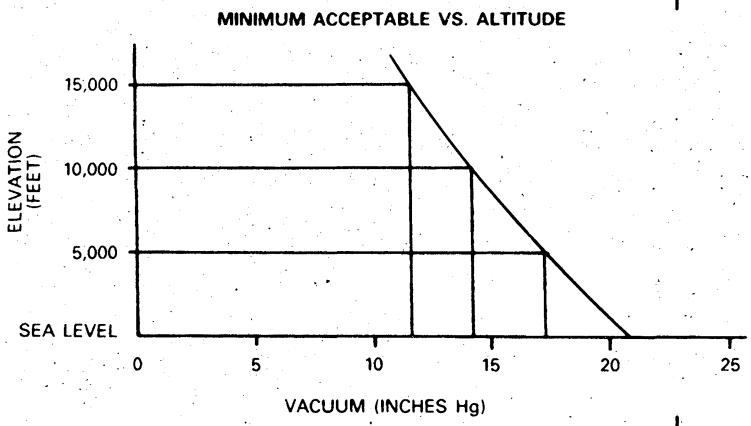


FIG. 1 Brake Booster Vacuum Pump—7.3L Diesel Engine Installation—E-250—E-350 and F-250—F-350

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VACUUM PUMP DIAGNOSIS

TEST STEP	RESULT	ACTION TO TAKE
1.0 CONDITION ISOLATION		
Disconnect the low-vacuum switch. Run engine at normal idle speed. Apply brakes.	Brake Warning Light illuminates ▶	Condition related to the hydraulic system. REFER to Section 12-01, General Hydraulic Brake Service.
	Brake Warning Light doesn't illuminate ▶	Condition related to the vacuum pump. GO to **2**.
NOTE: Before proceeding with the procedures, block the wheels, apply the parking brake and place the transmission selector in "PARK" or "NEUTRAL" before starting engine.		
2.0 VACUUM PUMP OUTPUT		
Disconnect the vacuum pump hose from the brake booster and insert a vacuum gauge, Rotunda Model 059-00008 or equivalent, in the hose end. Run the engine at normal curb idle and check vacuum. Gauge should read 70 kPa (21 inches Hg) at sea level within 30 seconds. (Refer to graph below for vacuum at other elevations.)	Vacuum at or above specified level (OK) ▶	GO to **4**.
	Vacuum below specified level or fluctuating gauge reading (OK) ▶	GO to **3**.
3.0 SYSTEM INTEGRITY CHECK		
Check gauge and connections for leaks. Check pulley fit-to-shaft. Check for belt tension to specified tension. Check that engine curb idle RPM is at specifications. Repeat procedure in Step 2.0 — "Vacuum Pump Output" Test.	Vacuum at or above specified level (OK) ▶	GO to **4**.
	Vacuum below specified level (OK) ▶	REPLACE vacuum pump.



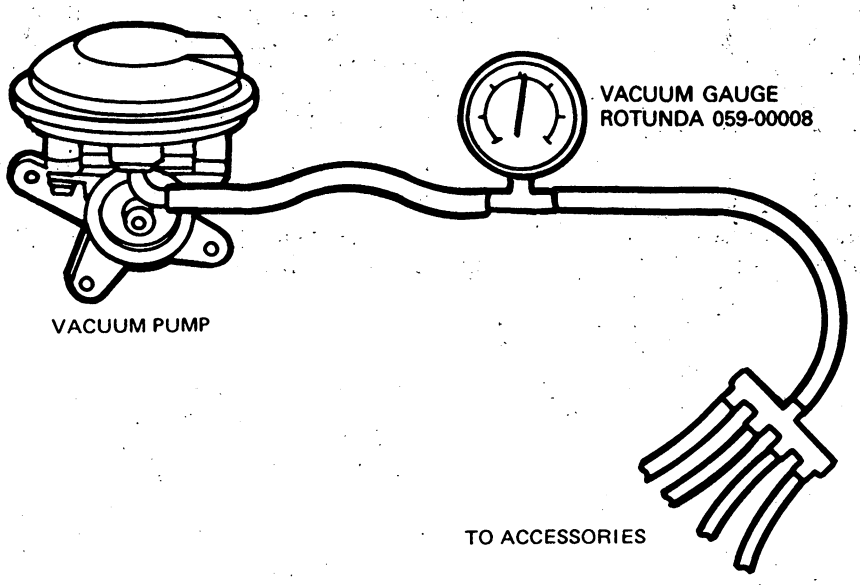
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VACUUM PUMP DIAGNOSIS (Cont'd.)

TEST STEP	RESULT	ACTION TO TAKE
4.0 VACUUM SYSTEM CHECK Reconnect the vacuum hose with a T-fitting and connect vacuum gauge so gauge is located near pump inlet. Run engine at curb idle speed. The maximum allowable vacuum drop to be 10 kPa (3 in. Hg.) from the specified level of vacuum described in Step 2.0 — "Vacuum Pump Output" Test.	Vacuum at or above specified level (OK) ▶	GO to **5**.
	Vacuum below specified level (OK) ▶	GO to **6**.
5.0 BRAKE BOOSTER CHECK Repeat Step 4.0 — "Vacuum System Check" with brake pedal depressed and held in position.	Vacuum at or above specified level (OK) ▶	CHECK Hydraulic System. REFER to Section 12-01, General Hydraulic Brake Service.
	Vacuum below specified level (OK) ▶	REPLACE brake booster.
6.0 LEAK CHECK Check all attaching hoses for leaks.	Vacuum hoses leak (OK) ▶	SERVICE as required.
	Vacuum hoses do not leak (OK) ▶	If vacuum is still low, check all vacuum accessories for out of specification leaks. REPAIR or REPLACE as required.

VACUUM SYSTEM CHECK



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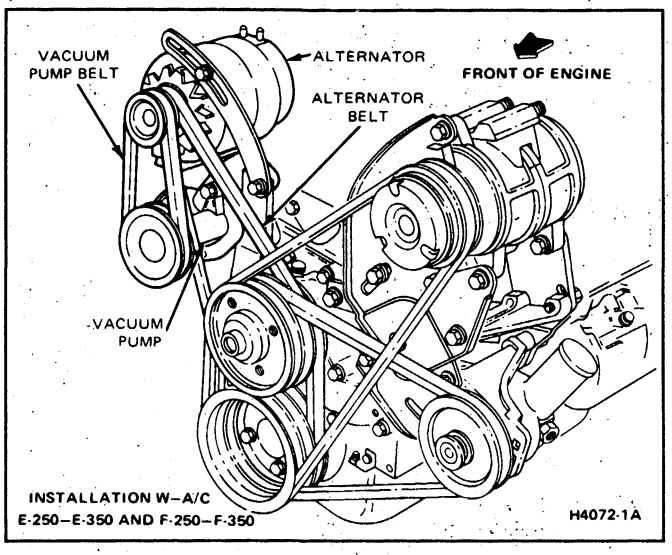


FIG. 2 Vacuum Pump Belt Tension

NOTE: The vacuum pump is not to be disassembled. It is only serviced as a unit. The pulley is serviced as a separate item.

Installation

1. Install the bolts attaching the pump to the adjustment plate and tighten the bolts to 15-25 N·m (11-18 ft-lbs). Position the pump and plate on the vacuum pump bracket and loosely install the pivot and adjustment bolts.
2. Connect the hose from the manifold vacuum outlet fitting to the pump and install the hose clamp (Fig. 1).
3. Install the drive belt on the pulley. Place a 3/8 inch drive breaker bar or ratchet into the slot on the vacuum pump adjustment plate. Lift up on the assembly until the specified belt tension is obtained. Measure tension with Belt Tension Gauge, T63L-8620-A or equivalent. (For belt tension specifications, refer to Specifications at the end of this Section.) Tighten the pivot and adjustment bolts to 15-25 N·m (11-18 ft-lbs).
4. Start the engine and verify proper operation of the brake system.

   NOTE: The BRAKE lamp will glow until vacuum builds up to the normal level.

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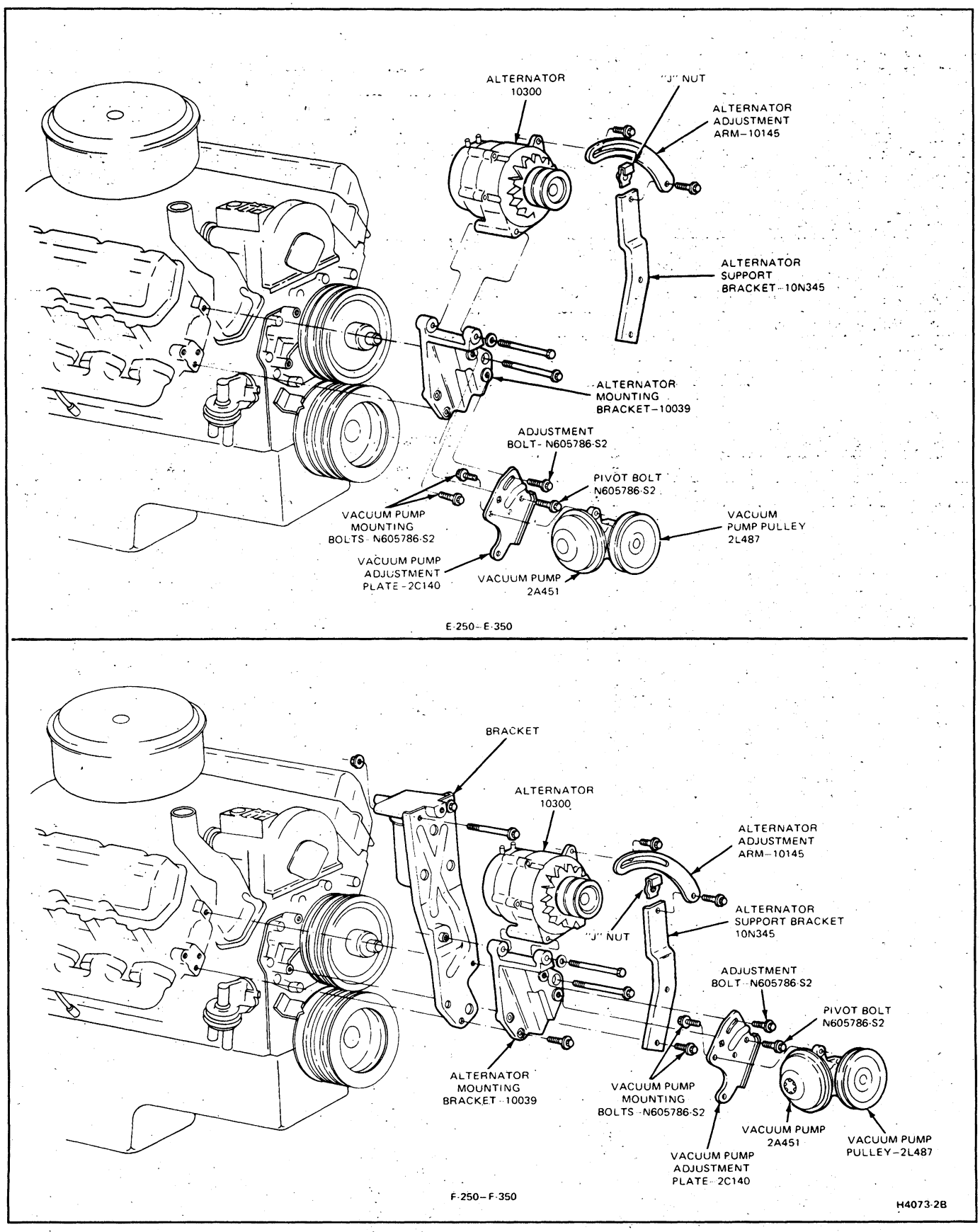


FIG. 3 Vacuum Pump Installation—Disassembly View

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SPECIFICATIONS

VACUUM PUMP BELT TENSION SPECIFICATIONS — 7.3L DIESEL ENGINE

Belt	New Belt				Used Belt			
	Cold Engine ①		Hot Engine		Minimum		Readjustment	
	Lbs	N	Lbs	N	Lbs	N	Lbs	N
Vacuum Pump Belt	90-130	400-578	110-150	489-667	60	266	80-100	355-444

①Engine not run in 3 hours.

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TORQUE SPECIFICATIONS

Description	Torque	
	N·m	Ft-Lbs
Vacuum Pump to Adjustment Plate Bolts	15-25	11-18
Vacuum Pump Adjustment Bolt	15-25	11-18
Vacuum Pump Pivot Bolt	15-25	11-18
Low-Vacuum Indicator Switch Bracket Screws	8-11	5.8-7.5

CH4075-2A

SPECIAL SERVICE TOOLS

Tool No.	Description
T63L-8620-A	Belt Tension Gauge

CH4076-1A

ROTUNDA EQUIPMENT

Tool Number	Description
059-00008	Vacuum/Pressure Tester

CH5402-1A

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SECTION 12-57 Hydro-Boost Brake Booster

SUBJECT	PAGE
ADJUSTMENTS	
Bleeding the Hydro-Boost Unit	12-57-10
DESCRIPTION AND OPERATION	
Description	12-57-1
Operation	12-57-3
DIAGNOSIS AND TESTING	
Diagnosis Guide	12-57-9
Diagnosis Guides	12-57-7
DIAGNOSIS AND TESTING (Cont'd.)	
Hydro-Boost Normal Noise Characteristics	12-57-6
DISASSEMBLY AND ASSEMBLY	12-57-14
REMOVAL AND INSTALLATION	12-57-11
SPECIFICATIONS	12-57-14
VEHICLE APPLICATION	12-57-1

VEHICLE APPLICATION

All F-Super Duty Chassis Cab, Stripped Chassis and Motor Home Chassis Vehicles.

DESCRIPTION AND OPERATION

Description

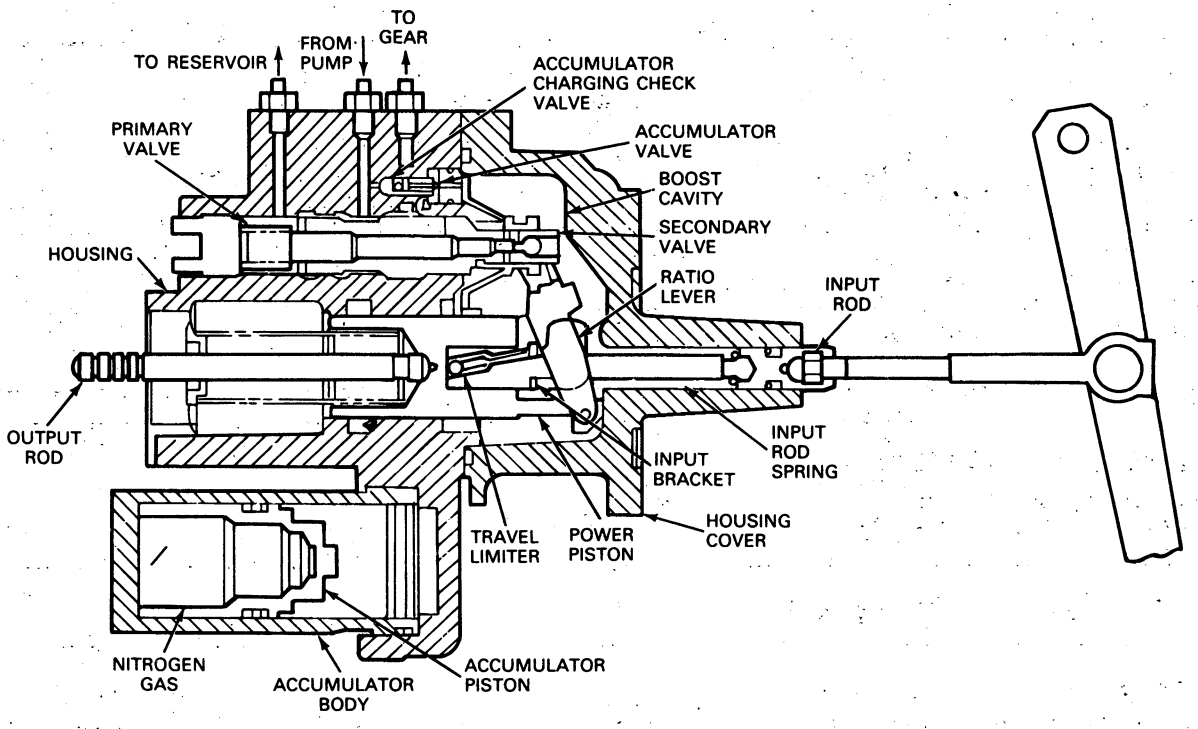
The Bendix Hydro-Boost brake booster is a hydraulically operated brake booster powered by the power steering system. The power steering pump provides the fluid pressure to operate both the hydraulically-powered brake booster (hydro-boost) and the power steering gear. It provides a variable power assist that is regulated by the brake pedal application pressure.

The hydro-boost also has a reserve system (compressed gas accumulator) that is designed to store sufficient fluid under pressure to provide at least two brake applications in the event that the fluid flow from the power steering pump is not available. The brakes can also be applied manually if the reserve system is depleted.

Hydro-Boost model identification is stamped into the booster housing near the inlet line.

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DESCRIPTION AND OPERATION (Continued)

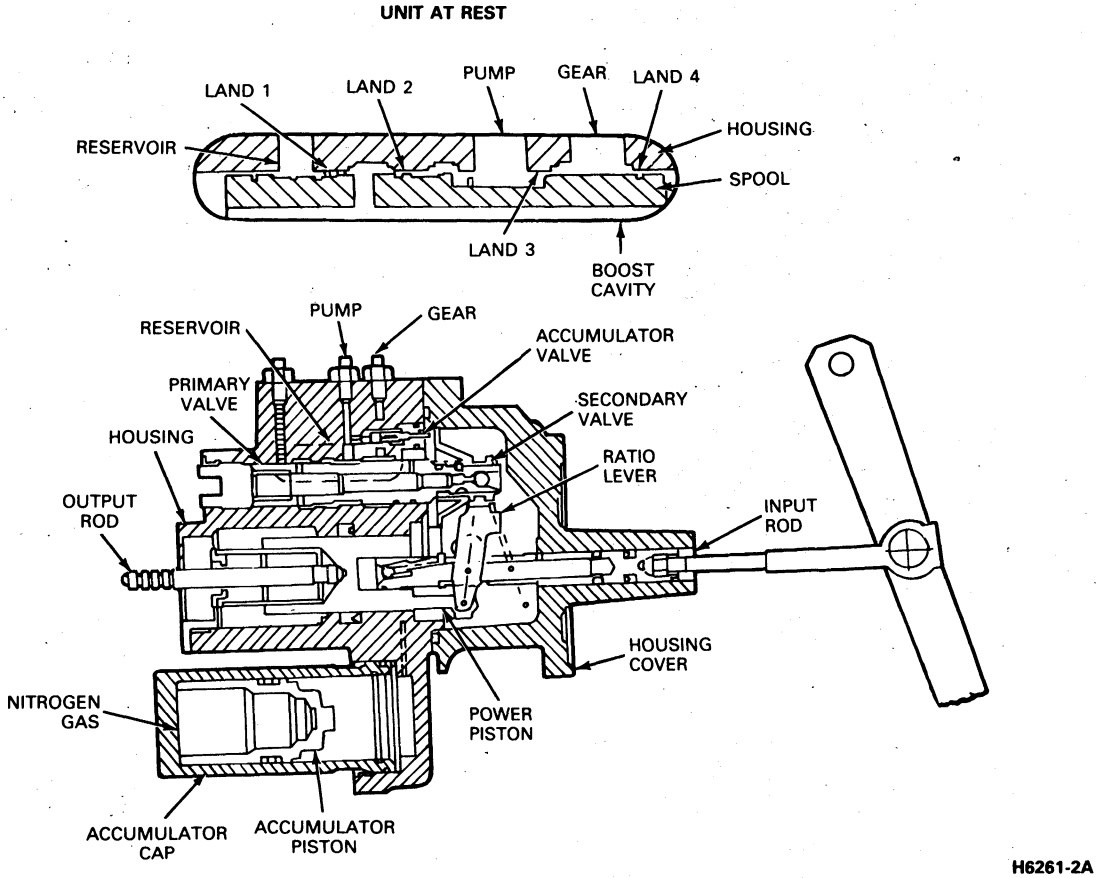


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DESCRIPTION AND OPERATION (Continued)

Operation

With the Hydro-Boost at rest (engine on, brakes released) oil flows from the inlet (pump) port, across the number 3 land and out the gear port. In this position, steering pressure created by the steering gear and pump is isolated from the boost cavity by the spool valve. Lands 2 and 4 block this steering pressure avoiding activation of the unit.

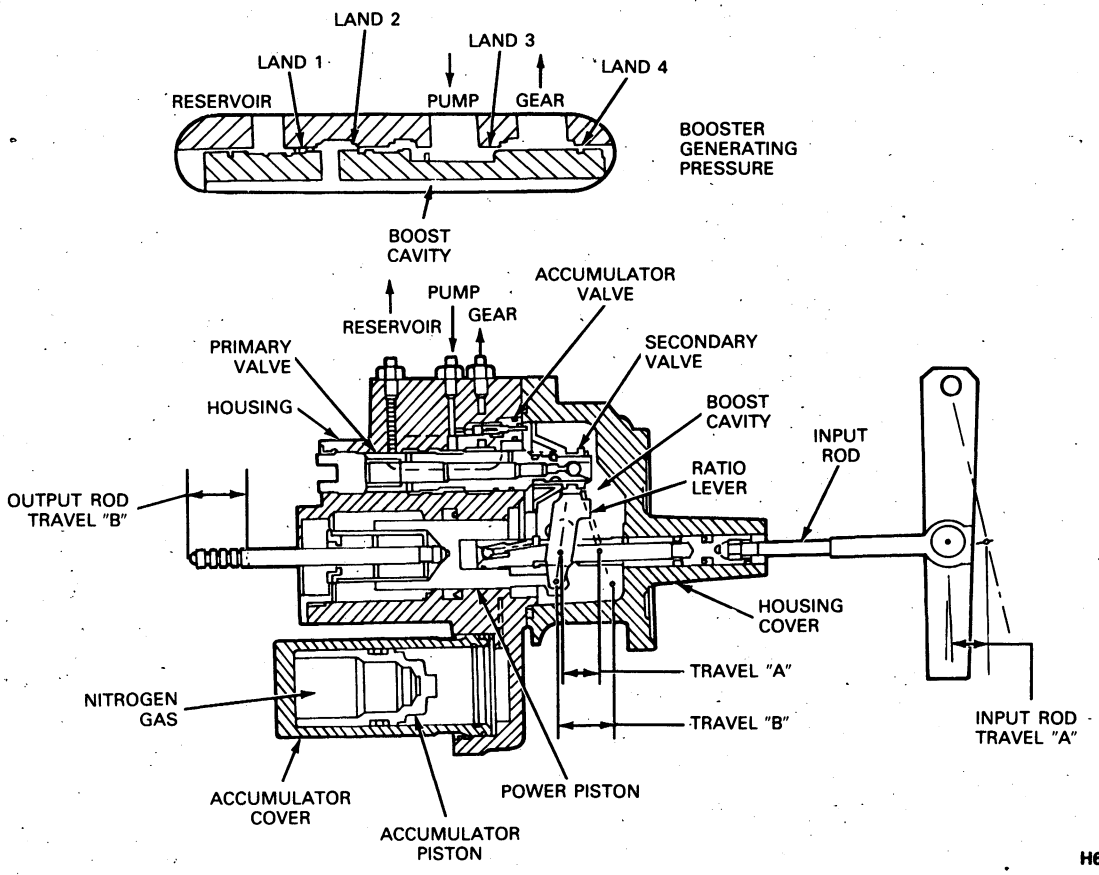


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DESCRIPTION AND OPERATION (Continued)

During normal power operation the brake pedal is applied as shown by input travel A. The movement of the ratio lever operates the spool valve creating hydraulic pressure due to the restriction at land 3. Fluid traverses land 2 and flows through the center of the spool into the boost cavity. This pressure acts against the power piston to give the power assist and against the reaction rod to provide the effort level of the brake pedal.

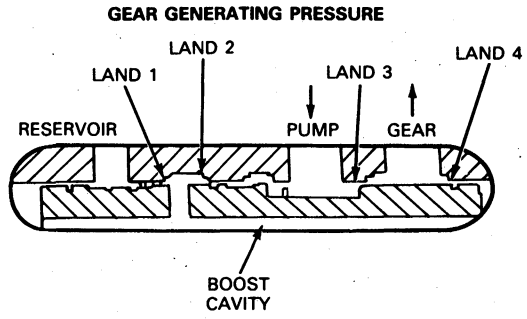
If while braking, fluid pressure is required for steering, pump pressure will rise and the spool valve will shift in an open direction allowing more fluid to flow to the steering gear. Even under extremes of braking, the fluid flow to the steering gear is fully sufficient for steering the vehicle.



H6262-2A

The enlarged view of the spool valve shows the relationship of the valve lands during normal power operation. Land 1 is closed blocking the oil flow to the reservoir. Land 3 meters the flow of oil from the supply pump to the steering gear and generates the hydraulic pressure that is metered across land 2 to apply the brakes.

The enlarged view of the valve shows the same operation except pressure is generated by the steering gear and is also being used for braking. During this mode of operation, the spool travel is slightly less than the first case.



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DESCRIPTION AND OPERATION (Continued)

Reserve System

The reserve braking system consists of a charging valve, an accumulator valve and a compressed gas accumulator. The system is open to the pressure port of the hydro-boost.

The accumulator is charged by the pump pressure during normal steering or braking operation through a check valve that communicates with the pump port.

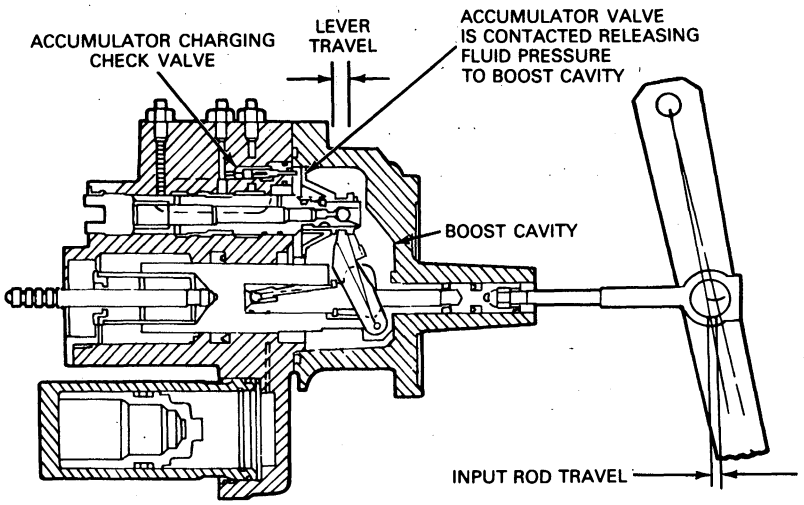
The charging valve has an orifice and a check valve. Fluid from the pump passes around the check valve into the accumulator if the pump pressure exceeds the pressure in the accumulator. The charging rate is controlled by the orifice to minimize its effect on fluid flow to the steering gear. The check valve prevents reverse flow when the accumulator pressure is greater than pump pressure.

The accumulator valve is a small poppet-type valve held closed by the pressure stored in the accumulator. An actuator on the spool valve sleeve opens the accumulator valve when a stop with no pump pressure is made that requires use of the reserve system pressure.

Fluid pressure can also enter the accumulator from the boost chamber through the accumulator valve. This condition occurs whenever boost chamber pressure momentarily exceeds accumulator pressure.

A pressure relief valve vents the accumulator to the pump pressure port whenever pressure in the accumulator exceeds approximately 1,400 psi.

RESERVE OPERATION



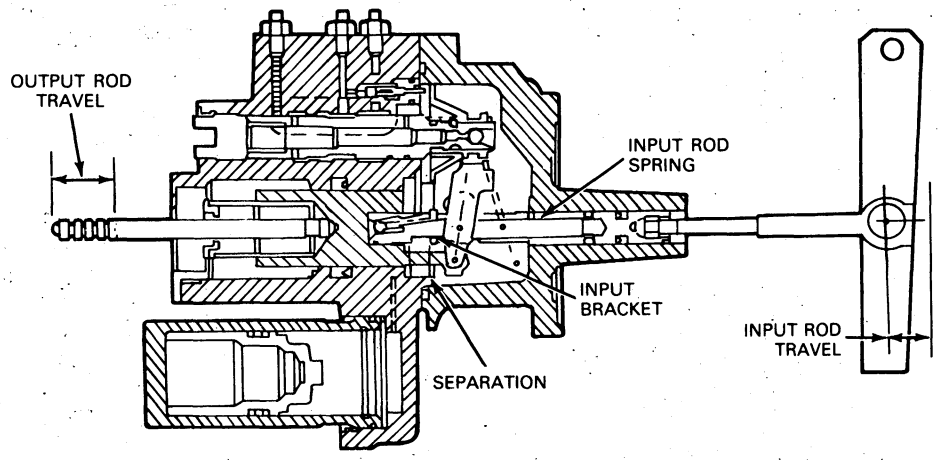
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DESCRIPTION AND OPERATION (Continued)

When reserve power is depleted (manual operation) pressure on the brake pedal will cause the input bracket to separate from a shoulder on the input rod, compresses the input spring and allows a change in the ratio of the brake pedal travel. This increase in brake pedal ratio will cause the brake pedal to travel further and increases the mechanical force applied to the master cylinder.

MANUAL OPERATION



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DIAGNOSIS AND TESTING

Hydro-Boost Normal Noise Characteristics

Normal hydro-boost brake units will produce certain characteristic noises that current technology cannot correct. These noises occur, for the most part, when the brake pedal is manipulated in a manner not associated with the everyday braking habits. The general categories of normal operating noise are hissing noise and clunk, click and chatter noises.

The hydro-boost will emit normal hissing noises when above normal pedal efforts are applied. The hiss sounds are particularly noticeable with the vehicle motionless and will increase in intensity as pedal efforts increase and system operating temperatures increase. Loud hissing sounds at or below normal 111-156 N (25-35 lbs) pedal effort warrants investigation and possible correction.

Clunk, chatter or clicking noises will be heard when the brake pedal is quickly released from hard pedal efforts. Due to "quick release for hard application" requirement for the noises, they will most likely be heard with the vehicle motionless or during a fast stop-start condition.

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DIAGNOSIS AND TESTING (Continued)

Diagnosis Guides

Refer to the following diagnosis guides for aid in diagnosing Hydro-Boost conditions. Additional information is available in Section 13-01, General Steering Service.

CONDITION	POSSIBLE CAUSE	RESOLUTION
Slow brake pedal return	1. Excessive seal friction in booster.	1. Replace booster.
	2. Flared reaction end.	2. Replace booster.
	3. Broken piston return spring.	3. Replace booster.
	4. Restriction in return line from booster to pump reservoir.	4. Clear or replace line.
	5. Return line incorrectly connected.	5. Correct plumbing.
	6. Broken spool return spring.	6. Replace booster.
	7. Heavy brake pedal.	7. Reposition pedal or add retracting spring.
Grabbing brakes	1. Broken spool return spring.	1. Replace booster.
	2. Faulty spool action due to contamination.	2. Flush steering while pumping brake pedal.
	3. Low pump flow.	3. Tighten belt.
Booster chatter, pedal vibration	1. Slipping pump belt.	1. Tighten belt.
	2. Low fluid level in pump.	2. Fill reservoir. Check for external leaks.
Accumulator leaks down. Reserve system does not hold charge.	1. Two-function valve is faulty.	1. Replace booster.
	2. Accumulator seal is faulty.	2. Replace booster.
	3. Pneumatic accumulator is faulty.	3. Replace booster.

CH6266-2A

CONDITION	POSSIBLE CAUSE	RESOLUTION
Excessive brake pedal efforts	1. Loose, glazed, or broken pump belt.	1. Tighten or replace belt.
	2. No fluid in pump reservoir.	2. Fill reservoir and check for external leaks.
	3. Leaks in system hoses.	3. Replace faulty parts.
	4. Leaks at tube fittings and connections.	4. Tighten fittings or replace tube seats or O-rings.
	5. Leakage at pneumatic accumulator seal.	5. Replace booster.
	6. Leakage at piston seal.	6. Replace booster.
	7. Leakage at input seal.	7. Replace booster.
	8. Leakage at cover-to-housing seal.	8. Replace booster.
	9. Leakage at spool plug seal.	9. Replace booster.
	10. Leakage at ball plug.	10. Replace booster.
Unit self-applies	1. Restriction in booster return line.	1. Clear or replace line.
	2. Return line incorrectly connected.	2. Correct plumbing.
	3. Dump valve faulty.	3. Replace booster.

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DIAGNOSIS AND TESTING (Continued)

Basic Test

With the engine off, depress and release the brake pedal several times to deplete all hydraulic pressure from the Hydro-Boost. Depress and hold the brake pedal with light pressure, then start the engine. If the Hydro-Boost is operating, the pedal will fall slightly and then hold. Less pressure will be required to hold the pedal at this position.

Brake Hydraulic Leak Test

Depress and release the brake pedal several times, then hold the brake pedal down with medium pressure (11-15 kg [25-35 lbs.]). If the pedal falls away, the brake system is leaking. Check for leaks at the disc brake calipers, brake lines, master cylinder, and hoses. If there is no external leakage, there may be internal leakage in the master cylinder. If the pedal does not fall away during this test then the hydraulic system is not leaking.

Hydro-Boost Leak Test

Thoroughly clean the Hydro-Boost unit, and all hoses and hose connections.

Start the engine and run at idle speed. If the hose connections do not leak, check the Hydro-Boost for leakage. Apply the brakes with approximately 45 kg (100 pounds) pressure at the pedal, and hold while checking the Hydro-Boost hoses for leaks.

CAUTION: Do not hold the brake pedal at 45 kg (100 Pounds) effort for more than five seconds at a time.

If the Hydro-Boost leaks, it is worn or damaged and must be replaced.

Reserve Retention Check

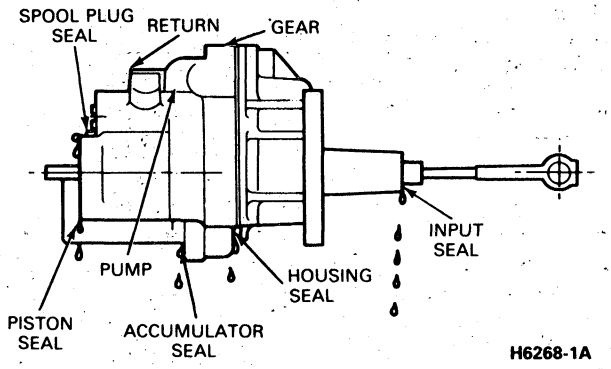
Charge the system with pressure by holding the steering on the stop, or by holding the brake pedal with 45 kg (100 pounds) of force for five seconds with the engine running at idle. Turn the engine off. Eight to twelve hours later depress the brake pedal with the engine off. There should be some degree of power reserve.

If there is no power reserve replace the Hydro-Boost unit.

Seal Leak Diagnosis

Possible sources of leakage from the Hydro-Boost unit are:

- Input seal
- Piston seal
- Housing seal
- Spool valve seal
- Accumulator cap seal
- Return port fitting seal



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DIAGNOSIS AND TESTING (Continued)

Diagnosis Guide

Preliminary Inspection

Road test the vehicle (if possible) to verify the complaint. Perform the preliminary inspection as listed below.

1. Check the power steering fluid level and condition.
2. Check the brake fluid level and condition.
3. Check the power steering pump belt for tension, glazing, and cracks.
4. Check the power steering hoses for leaks.
5. Check the brake pedal linkage for binding or sticky operation.

HYDRO-BOOST DIAGNOSIS GUIDE
NO POWER ASSIST

TEST STEP		RESULT ▶	ACTION TO TAKE
A0	VERIFY CONDITION		
• Road test the vehicle and check for booster operation.		(OK) ▶	Vehicle OK.
		(OK) ▶	GO to **A1**.
A1	FLUID LEVEL		
• Check power steering pump fluid level.		(OK) ▶	GO to **A2**.
		(OK) ▶	Check Hydro-Boost leak points, add fluid. REPEAT test **A0**.
A2	BELT CHECK		
• Check the power steering belt tension, and condition.		(OK) ▶	GO to **A3**.
		(OK) ▶	ADJUST belt tension. REPEAT test **A0**.
A3	PUMP SPEED		
• Check engine idle speed against specifications.		(OK) ▶	GO to **A4**.
		(OK) ▶	SET engine idle speed to specifications. REPEAT test **A0**.
A4	PUMP FLOW AND RELIEF		
• Test the power steering pump for proper flow and relief pressure (Section 13-01).		(OK) ▶	REPLACE booster.
		(OK) ▶	REPAIR or REPLACE pump. REPEAT test **A0**.

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DIAGNOSIS AND TESTING (Continued)

HYDRO-BOOST DIAGNOSIS GUIDE — Continued
ERRATIC OPERATION — STICKS, BINDS, OR GRABS

TEST STEP		RESULT	ACTION TO TAKE
B0	VERIFY COMPLAINT		
• Road test the vehicle, check operation.		OK	Vehicle OK.
		~~OK~~	GO to **B1**.
B1	PEDAL OPERATION		
• Perform the brake pedal operation test, as outlined in this section.		Pedal is free	GO to **B2**.
		Pedal binds	CORRECT pedal linkage binding. REPEAT test **B0**.
B2	HOSE CHECKS		
• Check for obstructions in the return line and connections between the Hydro-Boost and pump reservoir.		OK	GO to **B3**.
		~~OK~~	REMOVE obstruction or REPLACE line. REPEAT test **B0**.
B3	BOOSTER OPERATION		
• Check the brake fluid in the reservoir while rapidly applying the brake pedal one inch.		Brake fluid shows some movement or spouting	System OK.
		No fluid movement	REPLACE Hydro-Boost unit.

CH6270-2A

ADJUSTMENTS

Bleeding the Hydro-Boost Unit

1. Fill the pump reservoir with Motorcraft Mercon® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or DDX (ESP-M2C138-CJ), or equivalent.
2. Crank the engine for several seconds, with the coil wire disconnected (do not start the engine).
3. Check the fluid level, and add if necessary.
4. Start the engine.
5. With the engine running, turn the wheels lock to lock two times. Turn the engine off.
6. Depress the brake pedal several times to discharge the accumulator.
7. Repeat Steps 4 and 5.
8. If foaming occurs, stop the engine and allow the foam to dissipate.
9. Repeat Steps 4 and 5 as required, until all the air is removed from the system.

NOTE: The Hydro-Boost is generally self-bleeding, and the above procedure will normally bleed the air from the booster. Normal operation of the vehicle will further remove any additional trapped air.

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REMOVAL AND INSTALLATION

Removal

1. With the engine off, depress the brake pedal several times to discharge the accumulator.
2. Remove the master cylinder from the Hydro-Boost unit. Prop the master cylinder up and out of the way.

CAUTION: Do not apply the booster with the master cylinder removed.

3. Disconnect all three hydraulic lines from the booster.
4. Disconnect the input pushrod from the brake pedal assembly.
5. Remove the booster mounting nuts, and remove the booster from the vehicle.

CAUTION: The booster should not be carried by the accumulator, nor should it ever be dropped on the accumulator. The snap ring on the accumulator should be checked for proper seating before the booster is used. The accumulator contains high pressure nitrogen gas and can be dangerous if mishandled.

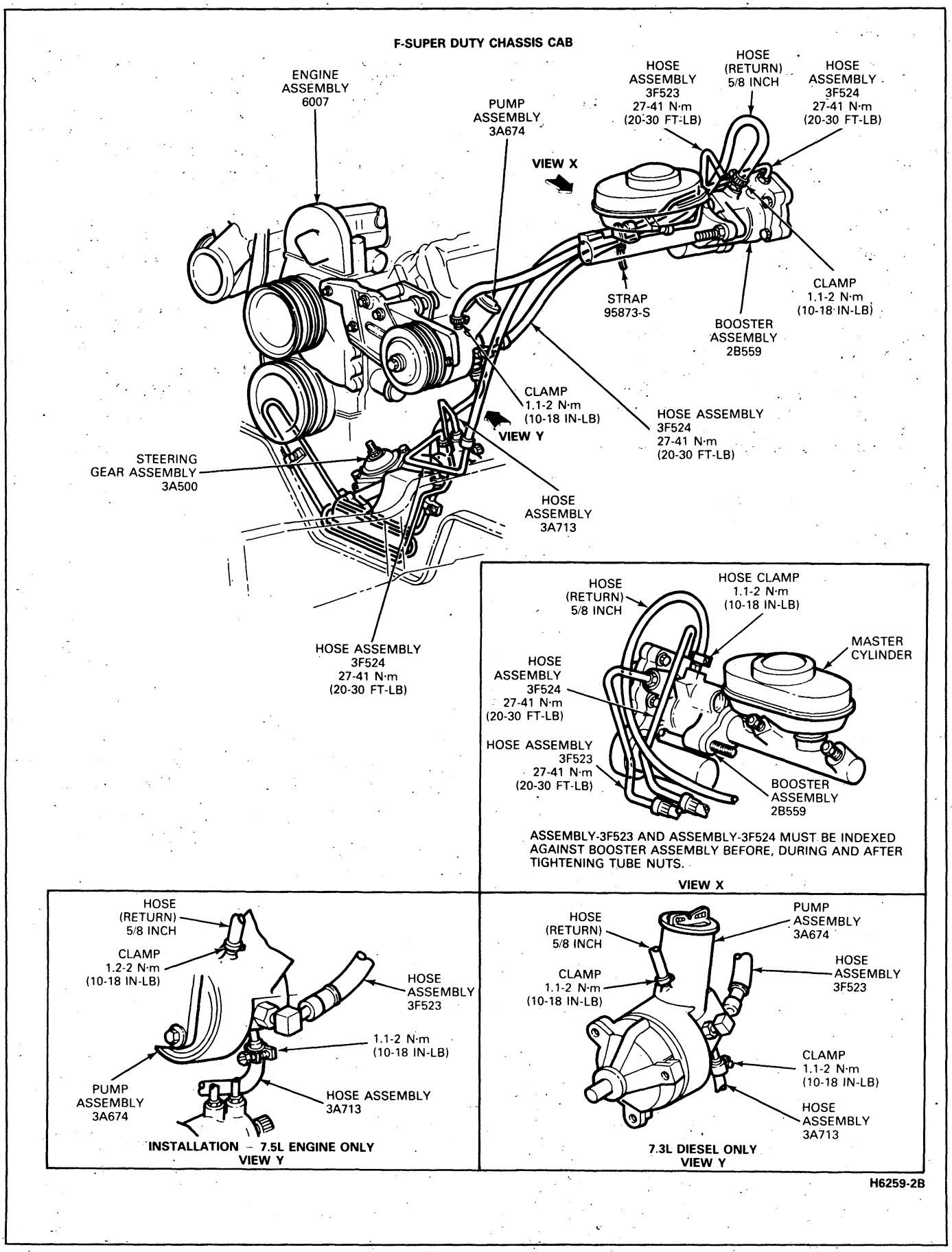
CAUTION: If the accumulator is to be disposed of it must not be exposed to excessive heat, fire or incineration. Before discarding the accumulator, drill a 1/16 inch diameter hole in the end of the accumulator can to relieve the gas pressure. Always wear safety glasses when performing this operation.

Installation

1. Install the booster in the vehicle and tighten the mounting nuts to 25-33 N·m (18-25 ft-lbs.).
2. Connect the input pushrod to the brake pedal assembly.
3. Position the master cylinder against the booster and tighten the mounting nuts to 25-33 N·m (18-25 ft-lbs.).
4. Connect the three hoses to the Hydro-Boost unit. Refill the system and bleed as required.

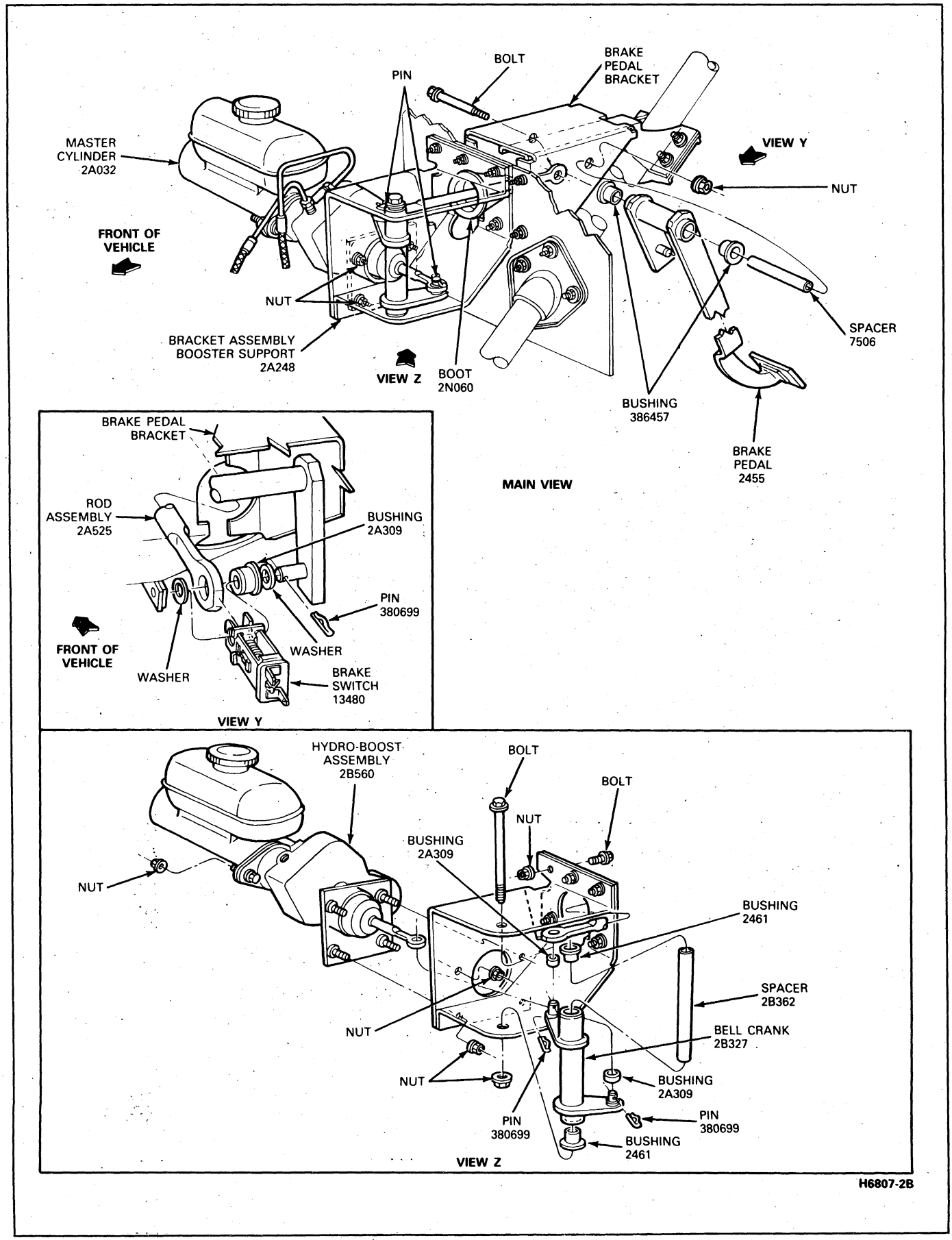
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REMOVAL AND INSTALLATION (Continued)



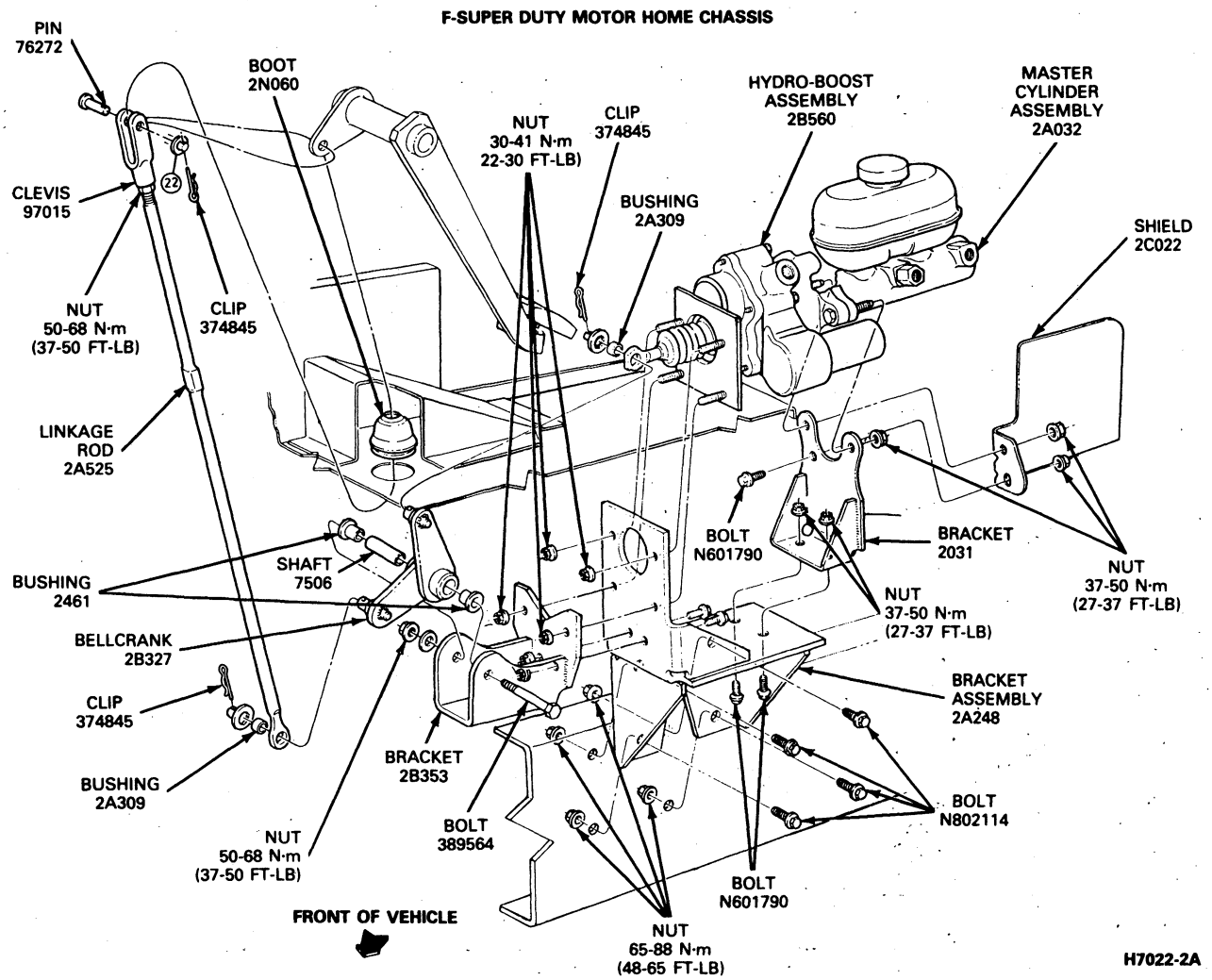
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REMOVAL AND INSTALLATION (Continued)



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REMOVAL AND INSTALLATION (Continued)



DISASSEMBLY AND ASSEMBLY

The Hydro-Boost power brake booster is not to be disassembled and is to be serviced as a unit.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Torque	
	N·m	Ft-Lb.
Booster Mounting Nuts	25-33	18-25
Booster Cover to Booster Body	30-32	22-24
Bracket to Booster Nut	149-155	110-114
Master Cylinder to Booster Nuts	25-33	18-25

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SECTION 12-70 Parking Brake—Cable Actuated, Rear Wheels and Transmission Mounted

SUBJECT	PAGE
ADJUSTMENTS	
Cable Actuated Rear Wheel Parking Brake	12-70-6
Cable Actuated Rear Wheel Parking Brake E-350 (Stripped Chassis)	12-70-6
Orscheln Parking Brake Lever	12-70-6
Cable Actuated Transmission Mounted Parking Brake	12-70-8
DESCRIPTION AND OPERATION	
Cable Actuated Rear Wheel Parking Brake	12-70-1
Cable Actuated Transmission Mounted Parking Brake	12-70-2
DIAGNOSIS AND TESTING	12-70-6
DISASSEMBLY AND ASSEMBLY	
Brake Shoes	12-70-13

SUBJECT	PAGE
DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Diagnosis Guides—Transmission Mounted Parking Brake	12-70-17
Transmission Mounted Parking Brake	12-70-12
Transmission Mounted Parking Brake	12-70-14
REMOVAL AND INSTALLATION	
Parking Brake Control	12-70-9
Parking Brake Equalizer to Control Assembly Cable	12-70-9
Parking Brake Equalizer to Rear Wheel Cable	12-70-10
Transmission Mounted Parking Brake	12-70-11
SPECIFICATIONS	12-70-18
VEHICLE APPLICATION	12-70-1

VEHICLE APPLICATION

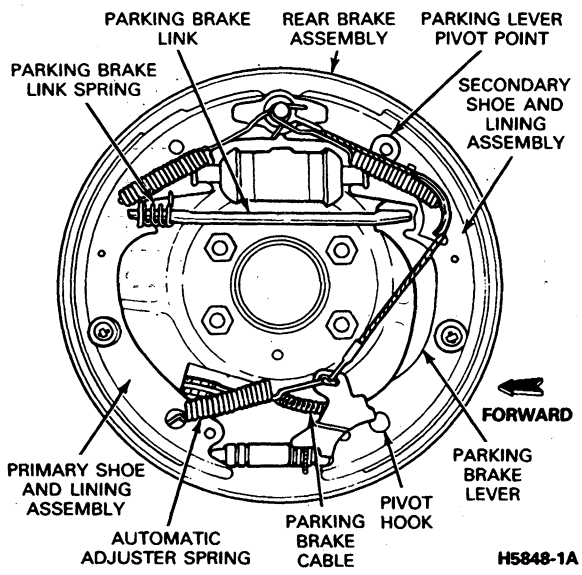
Applies to Bronco, E-150—E-350, F-150—F-350, F-Super Duty Chassis Cab, Commercial Stripped Chassis and Motor Home Chassis Vehicles.

DESCRIPTION AND OPERATION

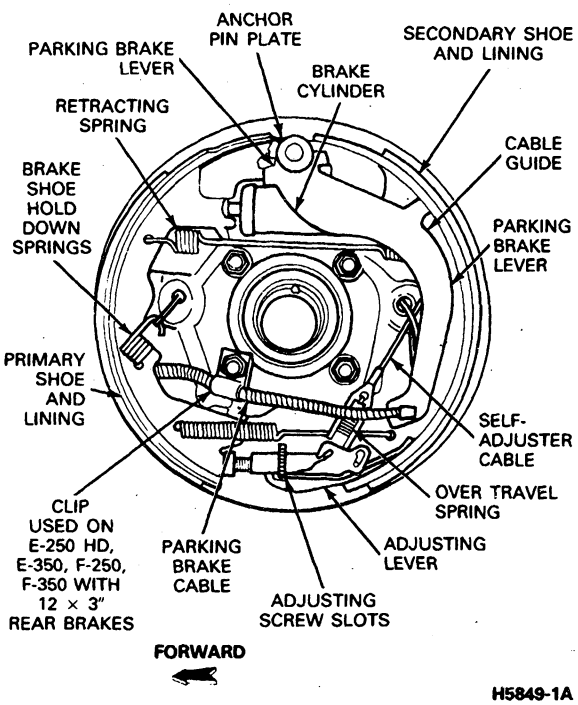
Cable Actuated Rear Wheel Parking Brake

On F-150—F-350, E-150—E-350 and Bronco, each rear wheel brake assembly contains a cable actuated parking brake assembly.

PARKING BRAKE ASSEMBLY – E-150, F-150 AND BRONCO



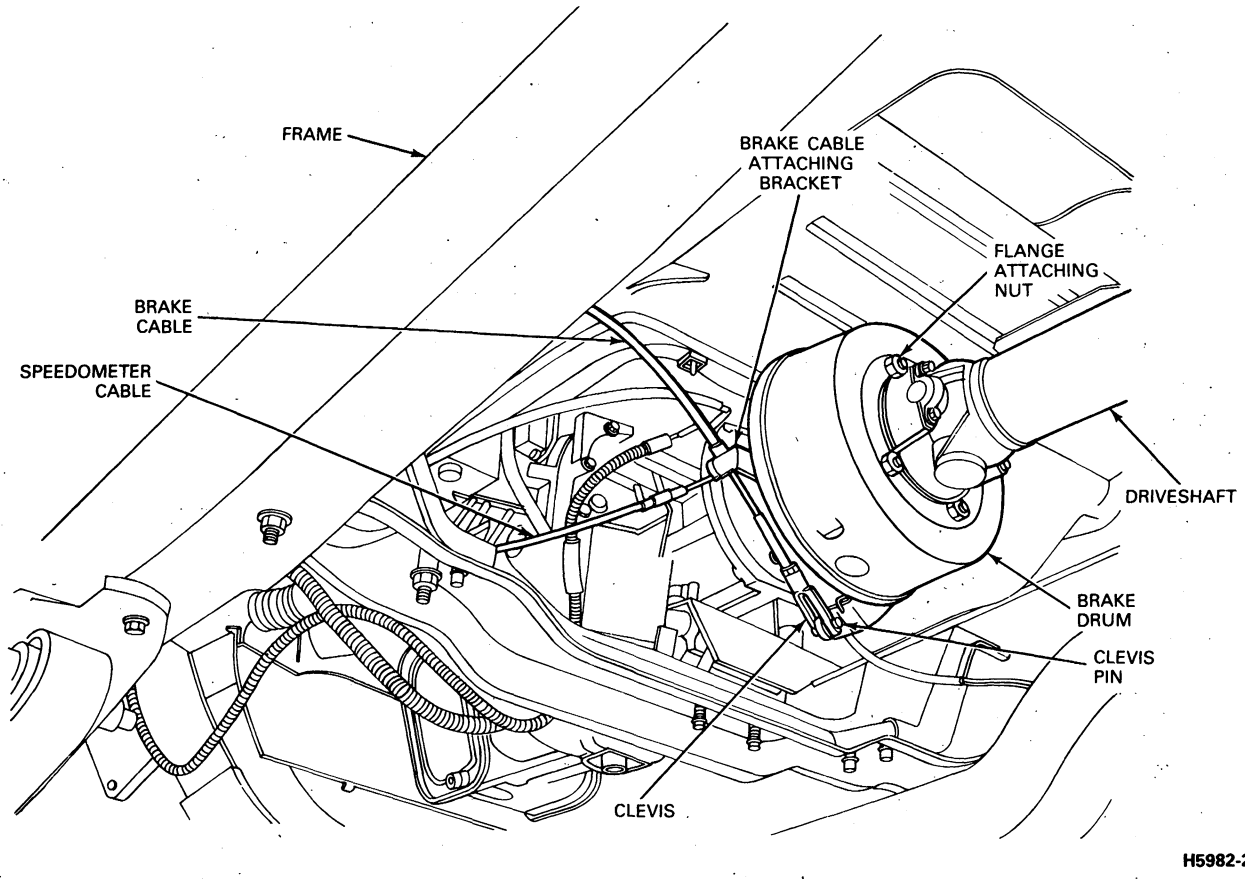
PARKING BRAKE ASSEMBLY – E-250, E-350, F-250, F-350 REAR BRAKES – WEB LEDGE BRAKE



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DESCRIPTION AND OPERATION (Continued)

Cable Actuated Transmission Mounted Parking Brake



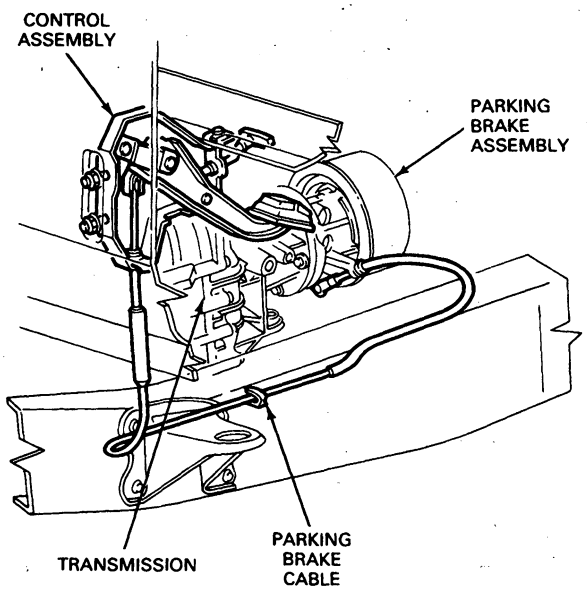
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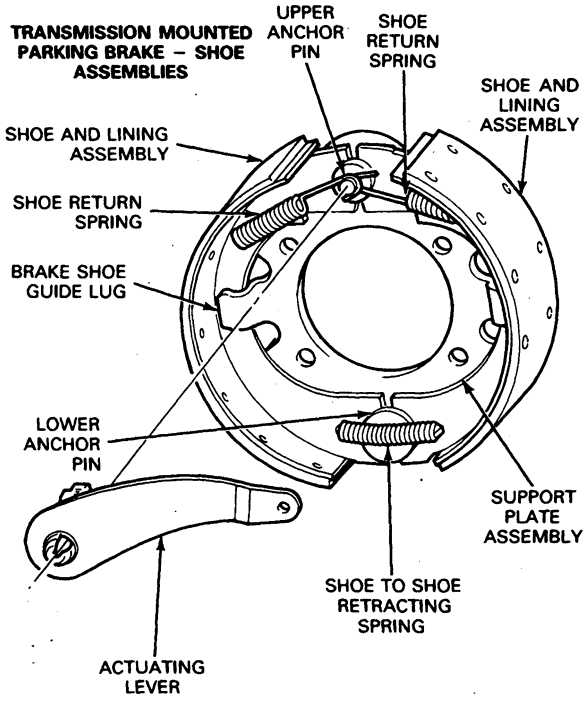
DESCRIPTION AND OPERATION (Continued)

A transmission mounted manually operated parking brake is used on F-Super Duty vehicles.

It is mounted to the transmission extension housing and it incorporates a case assembly and a cable actuated 9x3 inch Bendix brake assembly.

The case assembly consists of opposed mounted roller bearings, companion flange and mainshaft assembly installed in an one piece aluminum housing. The speedometer and speedometer cable assembly are driven by the speedometer drive gear, splined to the mainshaft. The case assembly has its own lubrication supply, separate from the transmission. The parking brake is applied and released by a parking brake pedal on F-Super Duty Chassis Cab and Motor Home Chassis Vehicles. On Commercial Stripped Chassis Vehicles an Orscheln lever is used.



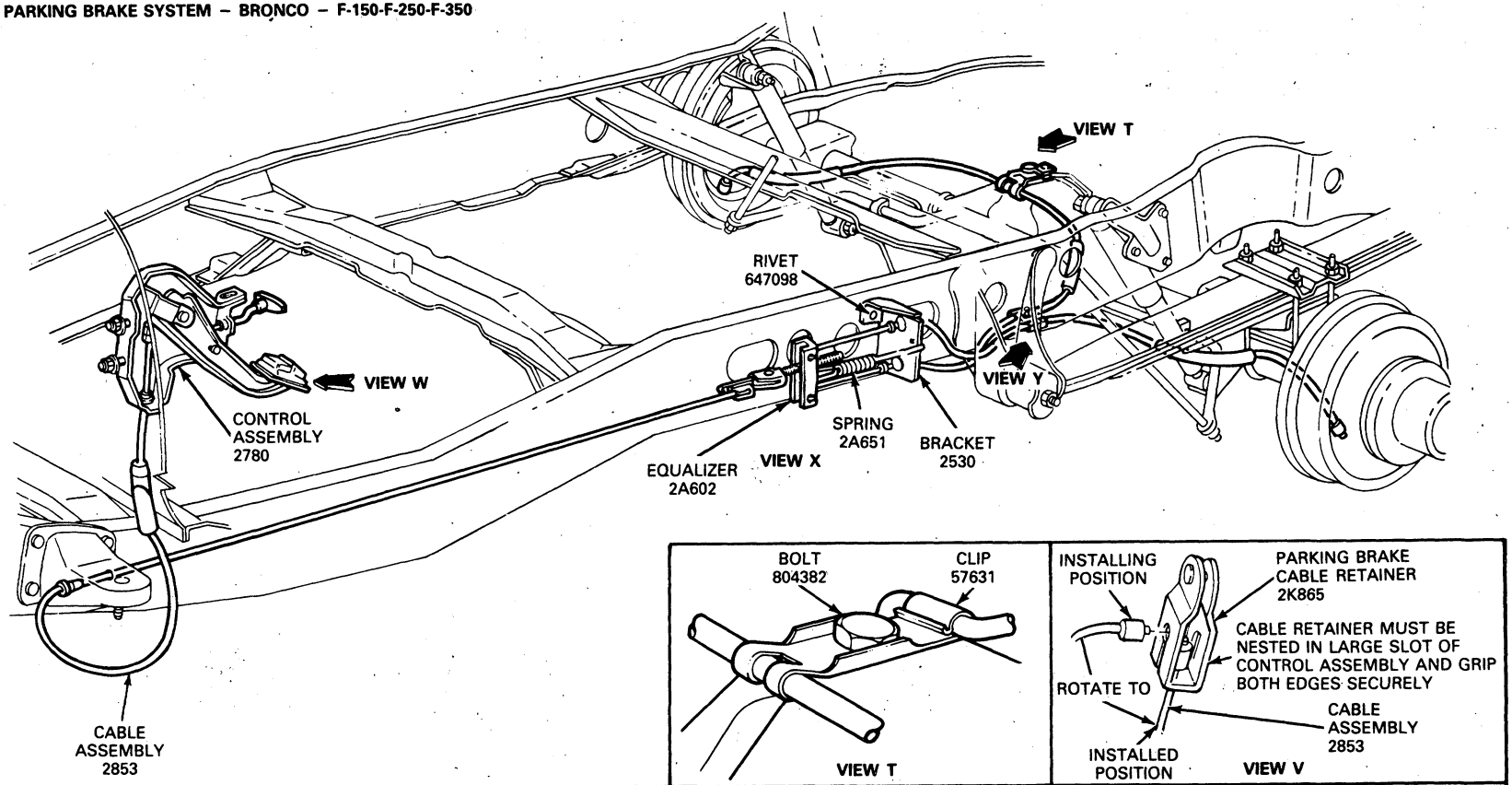


On F-150—F-350, E-150—E-350 and Bronco, the manually operated parking brake lever cable is routed to the equalizer lever which connects to the parking brake lever assembly in each rear wheel, through the equalizer assembly and brake cables.

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DESCRIPTION AND OPERATION (Continued)

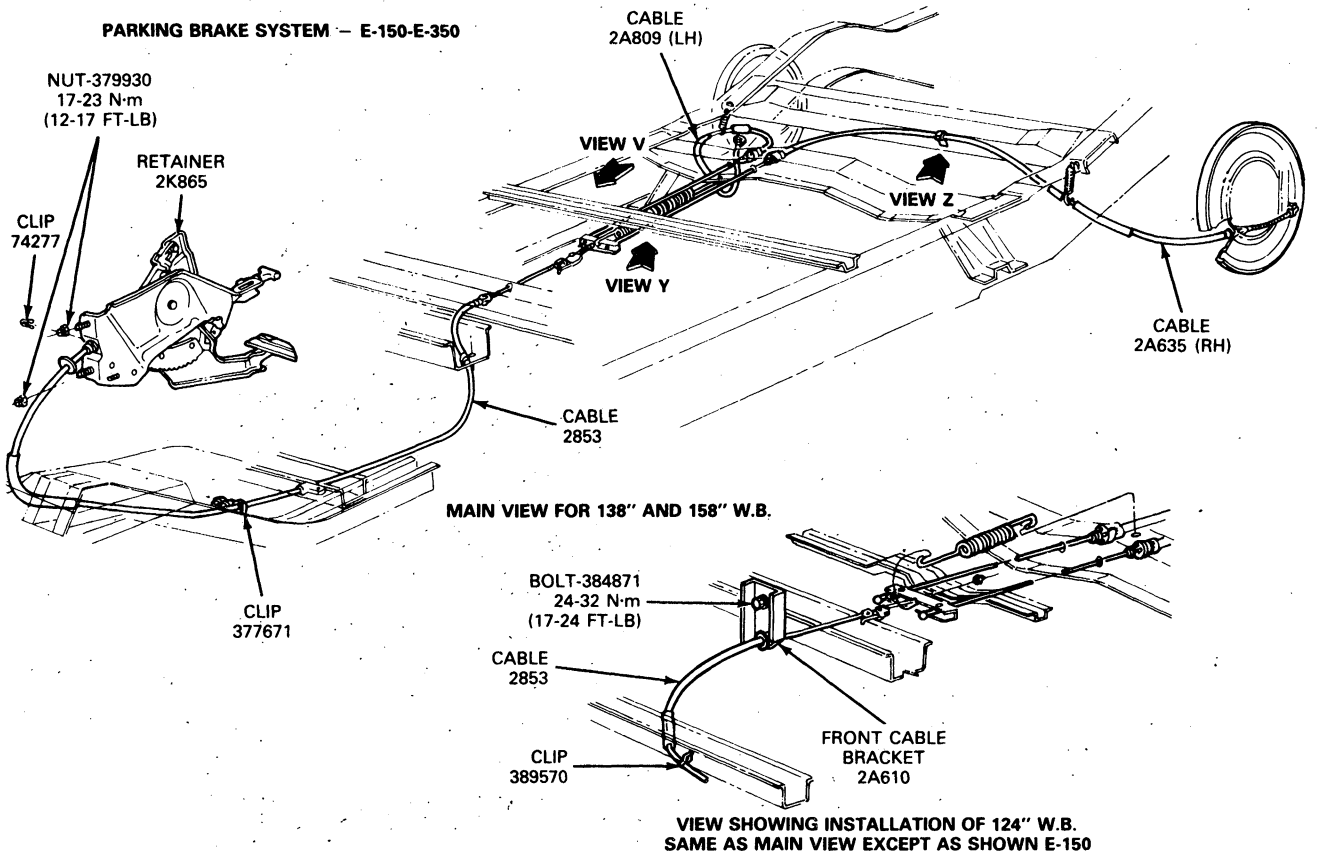
PARKING BRAKE SYSTEM – BRONCO – F-150-F-250-F-350

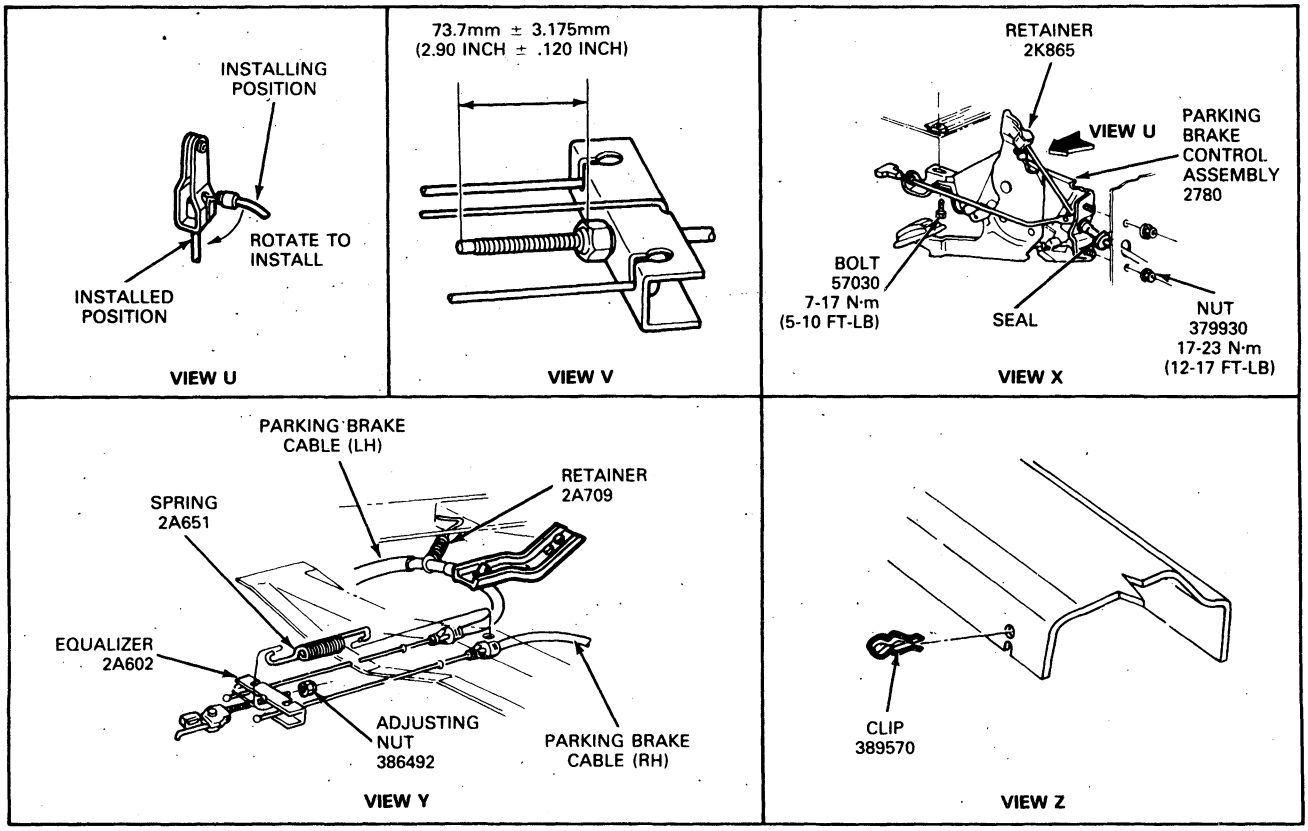


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DESCRIPTION AND OPERATION (Continued)





H2090-2M

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DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures. For F-Super Duty transmission mounted parking brake refer to Diagnosis Guides in this Section.

ADJUSTMENTS

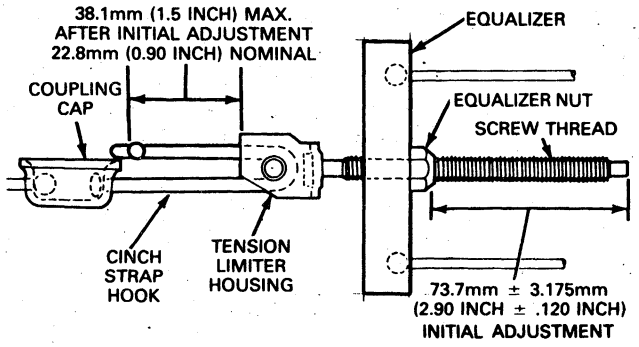
Cable Actuated Rear Wheel Parking Brake

F-150—F-350, Bronco, E-150—E-350 with Foot Operated Parking Brake Control

Adjust the drum brakes before adjusting the parking brake cables. Refer to the Adjustments portion of Section 12-02, Drum Brakes—Single Cylinder, Dual Piston.

Initial Adjustment Procedure All Light Trucks (Use This Procedure When a New Tension Limiter is Installed)

1. Depress the parking brake pedal fully to the last detent position.
2. Grip the Tension Limiter housing to prevent it from spinning and tighten the equalizer nut 73.7mm ± 3.175mm (2.90 inch ± .120 inch) up the rod.
3. Check to make sure cinch strap has slipped (less than 38.1mm or 1 1/2 inch remaining).



CABLE TENSION LIMITER ASSEMBLY H2876-1G

Field Adjustment (Use This Procedure To Correct A Slack System If New Tension Limiter Is Not Installed)

E-150—E-350, E-150—F-350 and Bronco

1. Make sure the brake drums are cold for correct adjustment.
2. Position the parking brake pedal to the fully depressed position, all the way to the floor.
3. Grip the tension limiter housing to prevent it from spinning and tighten the equalizer nut 6 full turns past its original position on the threaded rod.
4. Attach an appropriate cable tension gauge (Rotunda Model 21-0018 or equivalent) behind the equalizer assembly either toward the right or left rear drum assembly and measure cable tension. Cable tension should be at least 1556 N (350 lbs.) with the parking brake pedal fully in the last detent position. If tension is low, repeat Step 3.
5. Release parking brake and check for rear wheel drag. There should be no brake drag.

The cables should be tight enough to provide full application of the rear brake shoes, when the parking brake lever of foot pedal is placed in the fully applied position, yet loose enough to ensure complete release of the brake shoes when the lever is in the released position.

NOTE: The Tension Limiter will reset the parking brake tension any time the system is disconnected provided the distance between the bracket and the cinch strap hook is reduced during adjustment. When the cinch strap contacts the bracket, the system tension will increase significantly and over tensioning may result. If all available adjustment travel has been used, the tension limiter must be replaced.

Field Adjustment — Tight System

(Use this procedure to correct the parking brake system with high pedal efforts.)

E-150—E-350, F-150—F-350 and Bronco

1. Make sure brake drums are cold for correct adjustment.
2. Cycle the parking brake pedal to the fully applied position, all the way to the floor.
3. Release the parking brake and repeat Step 2.

NOTE: Trucks have a cable system that incorporates a "tension limiter", and actuating the pedal all the way to the floor will automatically set the proper tension and pedal feel.

4. On F-Super Duty Series vehicles, check the operation of the transmission mounted parking brake.

Cable Actuated Rear Wheel Parking Brake E-350 (Stripped Chassis)

Orscheln Parking Brake Lever

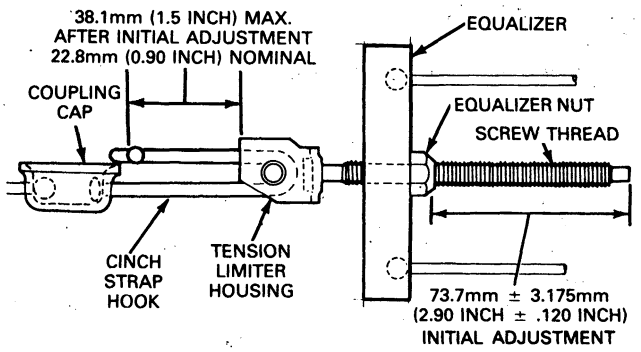
Adjust the drum brakes before adjusting the parking brake cables. Refer to the Adjustments portion of Section 12-02, Drum Brakes—Single Cylinder, Dual Piston.

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ADJUSTMENTS (Continued)

Initial Adjustment Procedure (Use this procedure when a new Tension Limiter is installed)

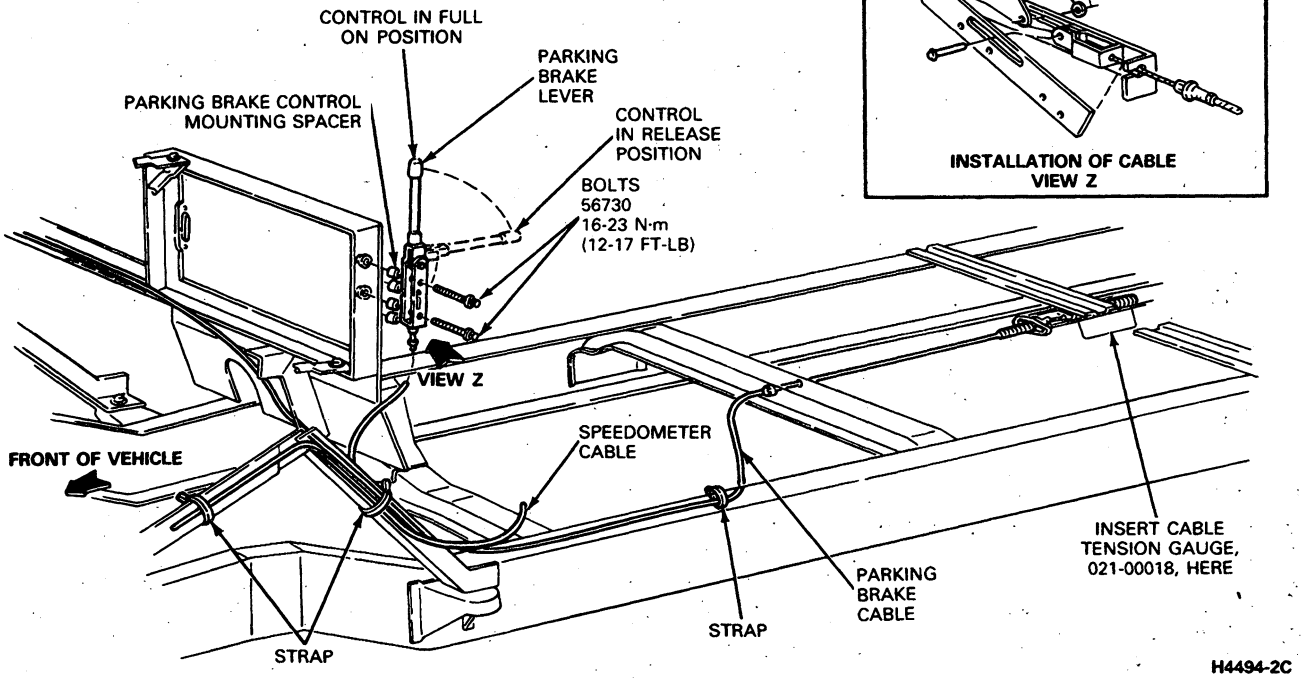
1. Turn the Orscheln parking brake handle adjustment knob clockwise to maximum travel and position the handle to the 'ON' position.
2. Grip the tension limiter housing to prevent it from spinning and tighten the equalizer nut 73.7mm ± 3.175mm (2.90 inch ± .120 inch) up the rod.



CABLE TENSION LIMITER ASSEMBLY H2876-1G

3. Check to make sure the cinch strap has slipped (less than 38.1mm or 1/2 inch remaining).
4. Release the parking brake handle to the 'OFF' position.
5. Back off the parking brake handle adjustment knob counter-clockwise to meet Cable Tension Gauge, 021-00018. (Reference dimension 63.5mm ± 3.175mm or 2 1/2 inch ± 1/8 inch.
6. With the parking brake lever in the full 'ON' position, the front parking brake cable tension should be a minimum of 1556 N (350 lbs).

PARKING BRAKE SYSTEM – E-350 WITH ORSCHELN PARKING BRAKE LEVER (STRIPPED CHASSIS MODEL)



INSTALLATION OF CABLE VIEW Z

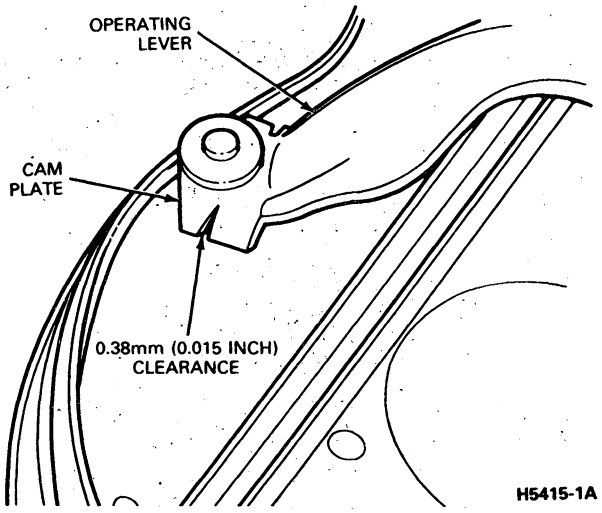
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ADJUSTMENTS (Continued)

Field Adjustment (Use this procedure to correct a slack system if a new Tension Limiter is not installed)

1. Make sure brake drums are cold for correct adjustment.
2. Place handle in the 'ON' (brake applied) position.
3. Grip the tension limiter housing to prevent it from spinning. Tighten the equalizer nut until the front cable tension measures 1556 N (350 lbs).
4. Place the handle in the released position then re-apply the parking brake system. Check that the front cable tension is at least 1378 N (310 lbs).
5. Release the parking brake and check for rear wheel drag.
6. If rear wheel brake drag is noted after adjustment, the rear drums must be removed after the service and parking brakes have been adjusted. Check the clearance between the parking brake lever and the cam plate. The clearance should be 0.38mm (0.015 inch) with the brakes fully released. If the clearance is not within specifications, readjust the parking brake cable.



NOTE: The Tension Limiter will reset the parking brake tension anytime the system is disconnected provided the distance between the bracket and the cinch strap hook is reduced during adjustment. When the cinch strap hook contacts the bracket, the system tension will increase significantly and over tensioning may result. If all available adjustment travel has been used the tension limited must be replaced.

7. Place the parking brake pedal in the fully released position, then check the slack in the parking brake two rear cables.

The cables should be tight enough to provide full application of the rear brake shoes, when the parking brake lever or foot pedal is placed in the fully applied position, yet loose enough to ensure complete release of the brake shoes when the lever is in the released position.

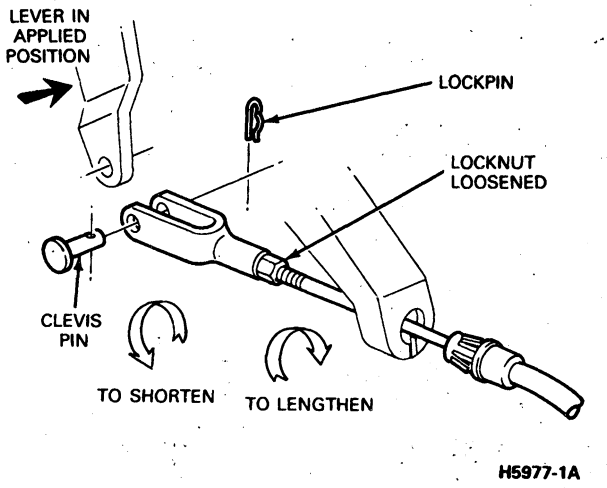
Cable Actuated Transmission Mounted Parking Brake

F-Super Duty Chassis Cab, Motor Home Chassis and Commercial Stripped Chassis Vehicles

Field Adjustment

Use this adjustment to correct excessive parking brake control travel.

1. Raise the vehicle on a twin post hoist and install safety stands.
2. Place the transmission in neutral, and release the parking brake.
3. Loosen the parking brake adjusting clevis jam nut several turns (spray the adjusting nut, threaded rod and the clevis with penetrating oil to ease adjustment).



4. Remove the locking pin and the clevis pin from the adjusting clevis.
5. While the lever is being held tight in the applied position, screw the clevis (clockwise) onto the threaded end of the cable until the clevis pin can be inserted freely into the clevis and the brake actuating lever while the lever is being held tight in the applied position, and the cable is tight.
6. Remove the clevis pin. Rotate the clevis 1O full turns in a counterclockwise (loosening) direction (about 1/2 inch). Install the clevis pin into position. Install the locking pin and tighten the clevis jam nut tight against the clevis. Recheck rotation of the driveshaft for freedom from drag.
7. Remove the safety stands and lower the vehicle down off the hoist.

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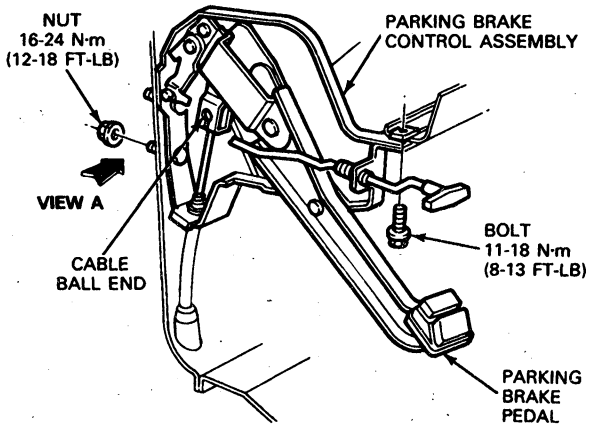
REMOVAL AND INSTALLATION

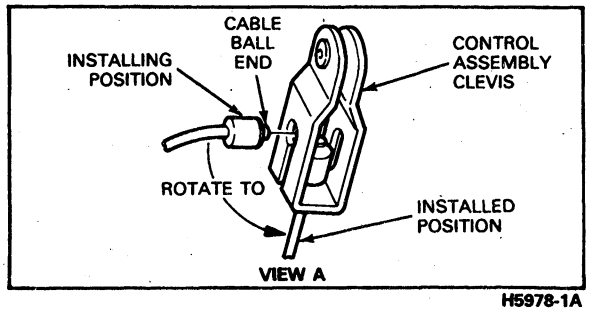
Parking Brake Control

F-150—F-350, E-150—E-350, Bronco and F-Super Duty

Removal

1. Loosen the adjusting nut at the equalizer. On F-Super Duty series vehicles remove the clevis pin at the parking brake.
2. Working from the engine compartment, remove the nuts attaching the parking brake control assembly to the dash panel.
3. Working under the instrument panel, remove the bolt attaching the control assembly to the lower flange of the instrument panel.
4. Remove the parking brake cable from the control assembly clevis by compressing the conduit end fitting prongs (using a 1/2 inch box wrench) holding the cable assembly to the control, remove the cable from the control. Remove the control.





Installation

1. Connect the forward ball end of the parking brake cable to the clevis of the control assembly, and insert the cable assembly into the control assembly. Install hair pin retainer.
2. Position the control assembly on the lower flange of the instrument panel and install the attaching bolt.
3. Working from the engine compartment, install and tighten the nuts that attach the parking brake control assembly to the dash panel 20.3 N·m (15 ft-lbs) torque.
4. Adjust the parking brake equalizer lever to its original position. On Super Duty series vehicles install the parking brake clevis pin. Check cable tension and adjust if necessary, as described in this Section.

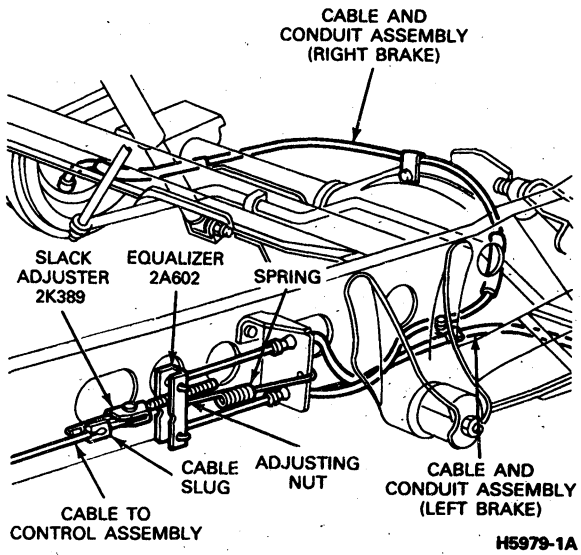
Parking Brake Equalizer to Control Assembly Cable

F-150—F-350, E-150—E-350, Bronco

Removal

1. Raise the vehicle on a hoist. Back off the equalizer nut and remove slug of front cable from the tension limiter.
2. Remove the parking brake cable from the cab mount (F-Series and Bronco) or crossmember (Econoline) and all retaining clips.
3. Lower the vehicle. Remove the forward ball end of the parking brake cable from the control assembly clevis.
4. Remove the cable from the control assembly by compressing the conduit end fitting prongs (use 1/2 inch box wrench).
5. Using a fish wire or cord attached to the control lever end of the cable, remove the cable from the vehicle.

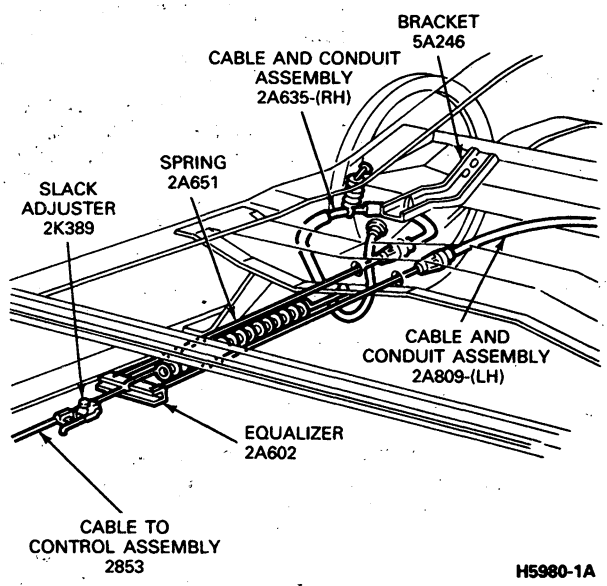
EQUALIZER INSTALLATION
F-150 – F-350 AND BRONCO – TYPICAL



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REMOVAL AND INSTALLATION (Continued)

EQUALIZER INSTALLATION E-150 – E-350 – TYPICAL



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Installation

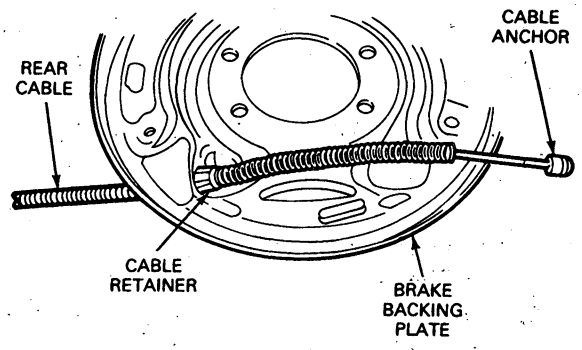
1. Transfer the fish wire or cord to the new cable. Position the cable in the vehicle, routing the cable through the dash panel. Remove the fish wire and secure the cable to the control.
2. Connect the forward ball end of the brake cable to the clevis of the control assembly. Raise the vehicle on a hoist.
3. Route the cable through cab mount (F-Series) or through the cross members (Econoline) and secure in place with retaining clips (Econoline).
4. Connect the slug of the cable to the Tension Limiter connector. Adjust the parking brake cable at the equalizer using initial adjustment or field adjustment, as appropriate.
5. Rotate both rear wheels to be sure that the parking brakes are not dragging.

Parking Brake Equalizer to Rear Wheel Cable

F-150—F-350, E-150—E-350, Bronco

Removal

1. Raise the vehicle and remove the hub cap, wheel, Tension Limiter and brake drum. Remove the locknut on the threaded rod and disconnect the cable from the equalizer.
2. Compress the prongs that retain the cable housing to the frame bracket (F-Series and Bronco) or crossmember (Econoline), and pull the cable and housing out of the bracket or crossmember.
3. Working on the wheel side compress the prongs on the cable retainer so they can pass through the hole in the brake backing plate. Draw the cable retainer out of the hole.



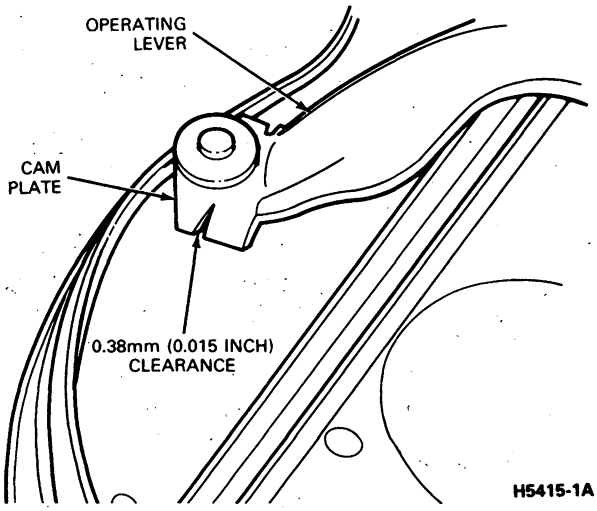
H5981-1A

4. With the spring tension off the parking brake lever, lift the cable out of the slot in the lever, and remove the cable through the brake backing plate hole.

Installation

1. Pull the cable through the brake backing plate until the end of the cable is inserted over the slot in the parking brake lever. Pull the excess slack from the cable and insert the cable housing into the brake backing plate access hole until the retainer prongs expand.
2. Insert the front end of the cable housing through the frame crossmember bracket until the prong expands. Insert the ball end of the cable into the key hole slots on the equalizer, rotate the equalizer 90° and recouple the Tension Limiter threaded rod to the equalizer.

   On **vehicles with web ledge brakes,** check the clearance between the parking brake operating lever and cam plate. The clearance should be 0.38mm (0.015 inch) when the brakes are fully released.



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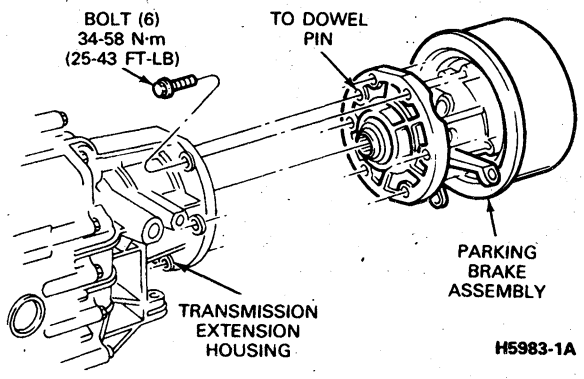
REMOVAL AND INSTALLATION (Continued)

3. Install the rear brake drum, wheel, and hub cap, and adjust the rear brake shoes.
4. Adjust the parking brake tension using initial adjustment or Field Adjustment procedure as outlined in this Section.
5. Rotate both rear wheels to be sure that the parking brakes are not dragging.

Transmission Mounted Parking Brake Assembly—F-Super Duty Series Vehicles

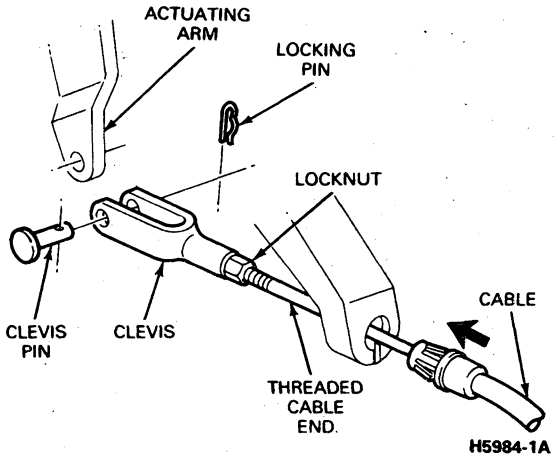
Removal

1. Place the transmission into gear and release the parking brake control cable. The pedal (or lever) must be in the fully released position.
2. Raise the vehicle on a twin post hoist and install safety stands.
3. Disconnect and remove the speedometer cable from the left hand side of the parking brake assembly.
4. Apply penetrating oil to the adjusting clevis, jam nut and the threaded end of the brake cable.
5. Loosen the jam nut and remove the locking pin from the clevis pin. Remove clevis pin, clevis, and jam nut from the brake cable. Remove cable from the bracket on the case.
6. Remove the bolts attaching the drive shaft to the parking brake assembly output flange. Remove the driveshaft and move it to one side out of the way. Wire it up to the frame.
7. Remove the 6 hex head bolts attaching the parking brake assembly to the transmission extension housing and remove the complete parking brake assembly from the transmission.

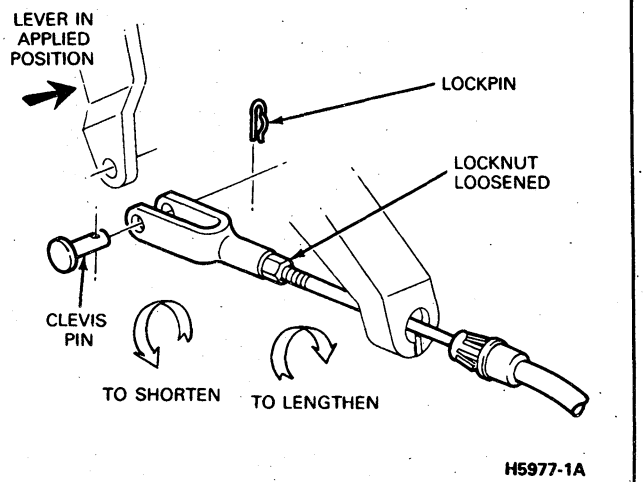


Installation

1. With the parking brake assembly in the as installed position, fill the parking brake assembly with Motorcraft MERCON® E4AZ-19582-B (ESP-M2C166-H) or equivalent to the bottom of the filler hole. Install and tighten the filler plug to 35-40 N·m (25-30 ft-lb).
2. Using two guide bolts or drift pins, attach the parking brake assembly to the transmission splined output shaft, and transmission extension housing.
3. Install 6 new hex head bolts to attach parking brake assembly to the transmission extension housing (Do not reuse old bolts). Tighten the bolts to 34-58 N·m (25-43 ft-lbs).
4. Attach the driveshaft to the output flange, and tighten the bolts to 20-27 N·m (15-20 ft-lbs).
5. Install the parking brake cable into the mounting bracket, and snap into position.



6. Screw the jam nut and adjusting clevis onto the threaded end of the brake cable.



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REMOVAL AND INSTALLATION (Continued)

7. Screw the clevis clockwise (tightening) until the clevis pin can be inserted freely into the clevis and the brake actuating lever, while the lever is being held tight in the applied position, and the cable is held tight.
8. Remove the clevis pin. Rotate the clevis 10 full turns in the counter clockwise (loosening) direction (about 1/2 inch).

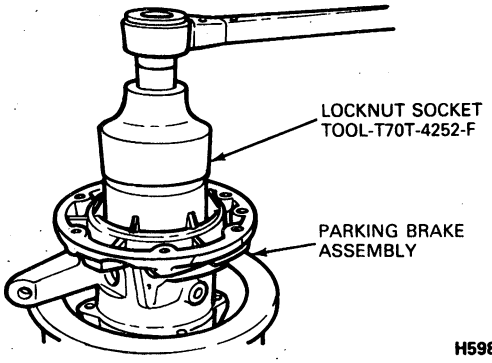
DISASSEMBLY AND ASSEMBLY

Transmission Mounted Parking Brake

Disassembly

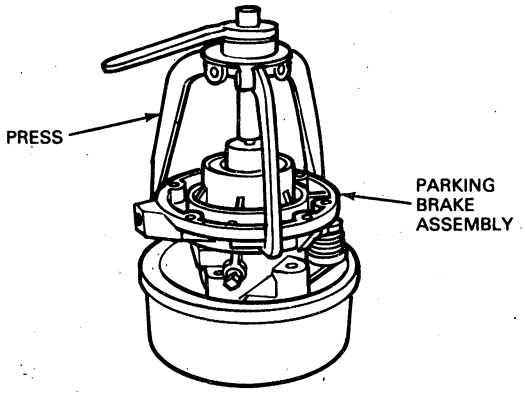
NOTE: To replace the brake assembly, brake shoe and lining assemblies, or other operational components the complete parking brake assembly must be removed from the vehicle.

1. Remove the parking brake assembly as outlined in Removal and Installation—Transmission Mounted Parking Brake, in this Section.
2. Using Tool T70T-4252-F or equivalent, remove the 65mm hex locknut from the mainshaft.



H5985-1B

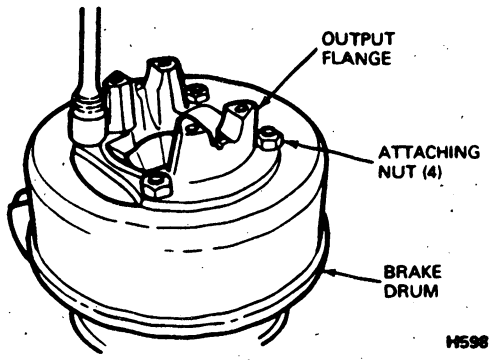
3. Using a suitable press, remove the mainshaft, brake drum and output flange out of the case assembly.



H7055-1A

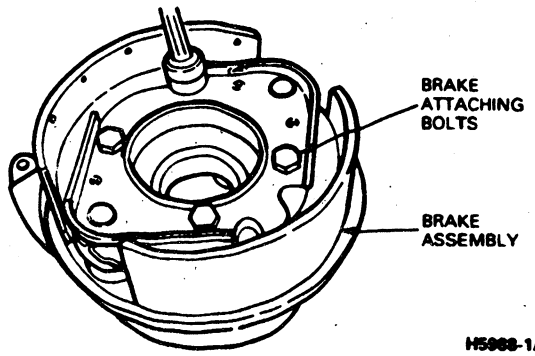
4. Remove the snap ring retaining the speedometer drive onto the shaft. Remove the speedometer drive gear.
5. Using puller D80L-1002-L with bearing cone remover D79L-4621-A and stop plate D80L-630-6, remove the inner bearing cone from the mainshaft.
6. Remove the output shaft and brake assembly from the vise. Turn the shaft assembly over and put the threaded end in the vise. Be sure to use soft jaw inserts to protect the mainshaft.
7. Remove the 4 hex nuts attaching the flange and brake drum to the output shaft. Remove the drum and flange from the output shaft.

NOTE: The drum, yoke/flange, and mainshaft are balanced as a unit, and must be marked to assure that they are assembled in the same position. Leave the bolts in the output flange.



H5987-1A

8. Remove the input shaft oil seal, spacer, O-ring, bearing cone assembly and bearing cup from the input shaft end of the case using tool number T77F-1102-A, or equivalent.
9. Remove the 4 bolts attaching the splash shield and brake assembly to the case. Remove the brake assembly and splash shield from the case.



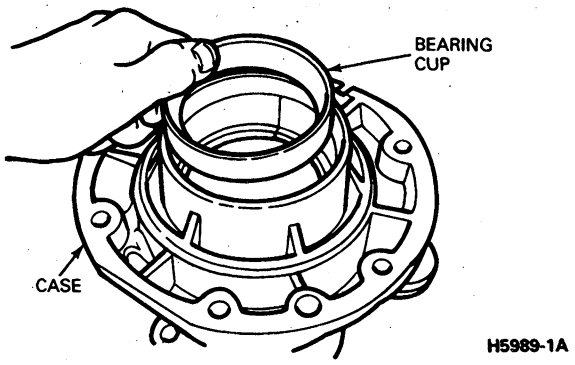
H5988-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

10. Remove the brake actuating lever and the lever spring from the case.

NOTE: For brake assembly component repair, refer to brake component repair in this Section.



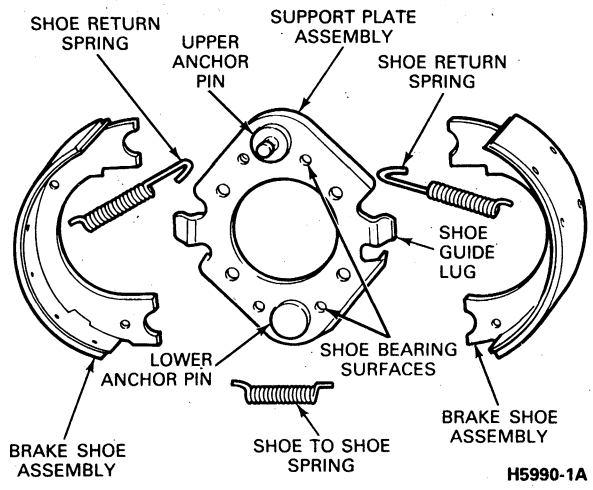
H5989-1A

11. Using tool T77F-1102-A remove the outer bearing cup.
12. Unscrew and remove the vent from the case.

Brake Shoes

Disassembly

1. Holding the brake assembly securely, remove the two brake shoe return springs using a suitable brake spring tool.
2. Spread the free ends of the brake shoes apart and remove the brake shoes from the lower anchor pin. Remove the shoe-to-shoe spring.
3. Clean any grease or contamination from the support plate. Remove contamination from the shoe guide lugs and other shoe bearing surfaces with sand paper.

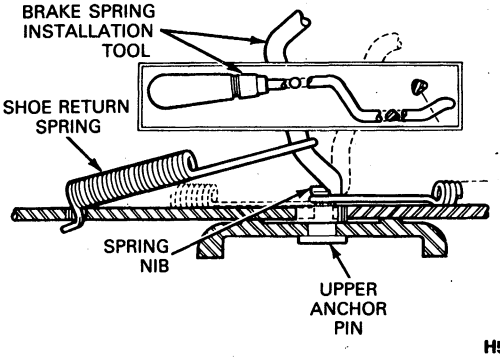


H5990-1A

4. Coat the following areas with Ford Disc Brake Caliper Slide Grease D7AZ-19590-A. Use only a light application of grease at these points.
   - Camshaft lugs and ball of actuating lever.
   - Shoe guide lugs and shoe bearing points of the support plate assembly.
   - Upper and lower anchor pins.
   - Anchor pin contact points of the brake shoes.

Assembly

1. Using new brake shoe and lining assemblies, install new shoe-to-shoe springs into the lower holes of the brake shoes.
2. Spread the opposite ends of the shoes and assemble the lower ends of the shoes over the shoulder of the lower anchor pin, twisting the shoes into position. Move the upper ends of the shoes to the upper anchor pin, inserting the shoe webs between the shoe guide lugs and the bearing surfaces of the support plate.
3. With the upper ends of the shoes against the upper anchor pin, install two new shoe return springs. Install the short hooked end of each spring into the upper holes of the brake shoes and hook the opposite end of each spring over the anchor pin nib, using a suitable spring installation tool. Be sure the open end of the spring hook faces toward the brake centerline.



H5991-1A

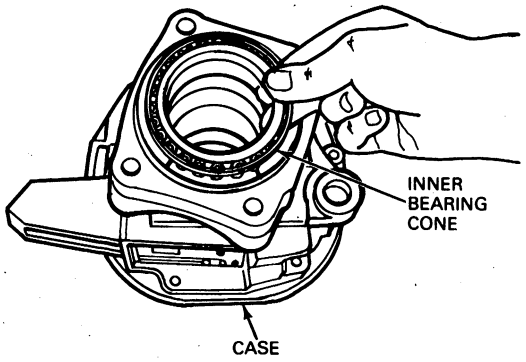
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DISASSEMBLY AND ASSEMBLY (Continued)

Transmission Mounted Parking Brake

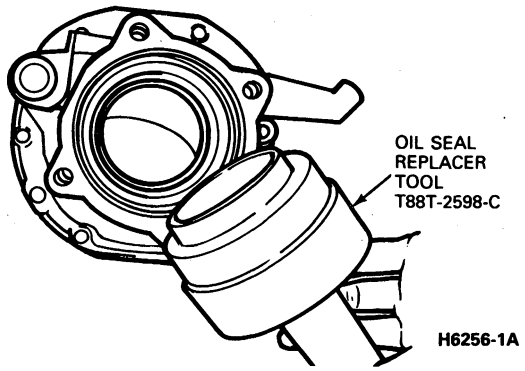
Assembly

1. Press the plug into the output flange if plug was previously removed. Apply sealer to the lip of the plug. Press into place with the lip of the plug facing outward. The plug must be flush with the edge of the bore.
2. Turn the case over and install the outer bearing cup into the case. Press in using tool T88T-2598-E (or equivalent) until the bearing cup bottoms in the bore.
3. Install the inner bearing cone assembly into the cup.



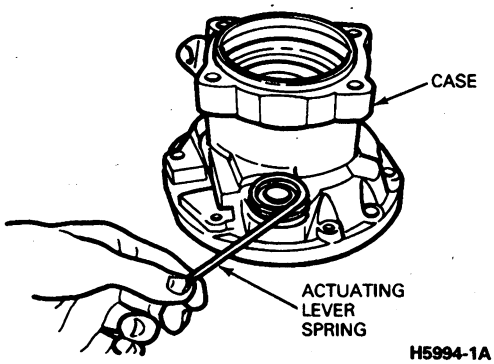
H7056-1A

4. Apply a light coating of sealer to the outer edge of the outer oil seal. Position the oil seal in the bore of the case with the sealing lip facing inward. Press the seal into the bore of the case using tool T88T-2598-C, or equivalent. Press the seal in flush with the bore surface.



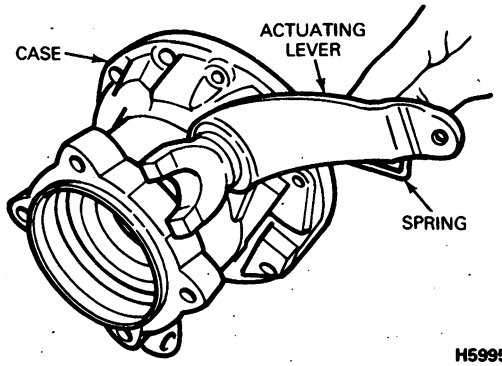
H6256-1A

5. Install the actuating lever spring in the boss in the case.



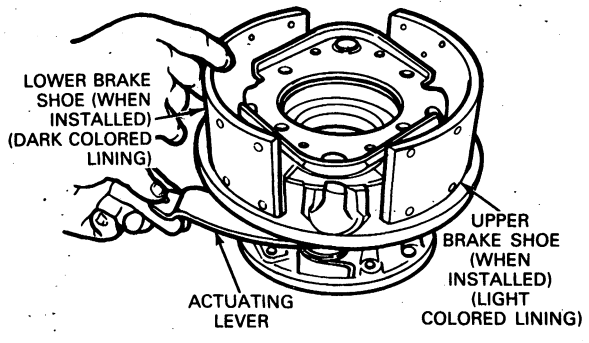
H5994-1A

6. Apply a light coating of Ford Disc Brake Caliper Slide Grease D7AZ-19590-A, or equivalent to the ball of the actuating lever. Install the lever (ball end) into the hole in the boss of the case, through the coiled end of the spring.



H5995-1A

7. Position the backing plate and brake assembly into position on the case. Insert the actuating lever (cam end) into position in the brake assembly.

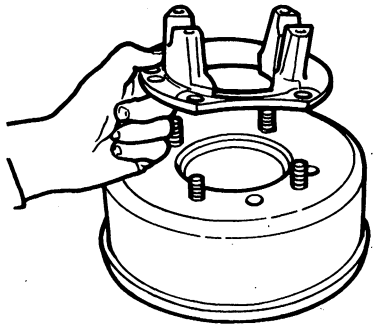


H5996-1A

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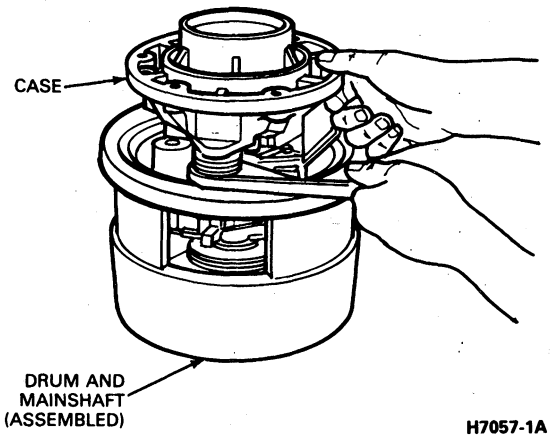
DISASSEMBLY AND ASSEMBLY (Continued)

8. Attach the brake assembly and backing plate to the case with 4 hex head bolts. Tighten the bolts to 118-122 N·m (87-91 ft-lb). Attach retracting spring to the actuating lever while bending the long end to snap over the lever.
9. Place the mainshaft in a vise with the flanged end up. Protect the shaft with soft jaw inserts.
10. Install the brake drum and output flange onto the flange end of the mainshaft.
11. Install the output flange onto the brake drum, aligning the marks made during disassembly (to insure that the balance is not disturbed). Install the 4 hex nuts and tighten to 113-117 N·m (83-87 ft-lb).



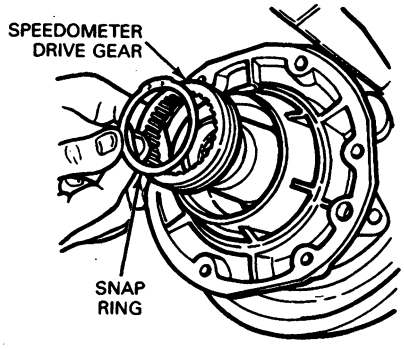
H5997-1B

12. Remove the mainshaft with drum assembly from the vise. Turn the unit over and clamp it securely in the vise.
13. Install the case, onto the mainshaft guiding the shaft through the oil seal and bearing cone.



H7057-1A

14. Using tool T88T-2598-F or equivalent, seat the output bearing onto the mainshaft.
15. Install the speedometer drive gear onto the mainshaft. Install the snap ring into the groove locking the speedometer gear to the shaft.

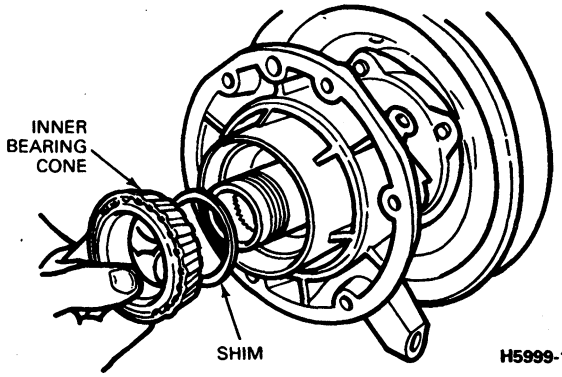


H5998-1A

16. Install the input bearing cup into the housing using tool T88T-2598-D, or equivalent.
17. Install the shim on the mainshaft.

NOTE: This shim determines mainshaft end play, and it is available in thicknesses in variances of 0.0019 inches.

18. Install the inner bearing cone onto the mainshaft.



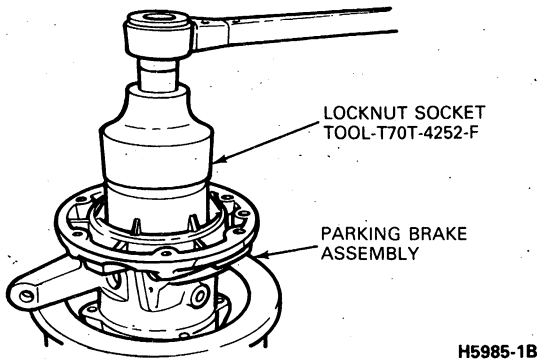
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DISASSEMBLY AND ASSEMBLY (Continued)

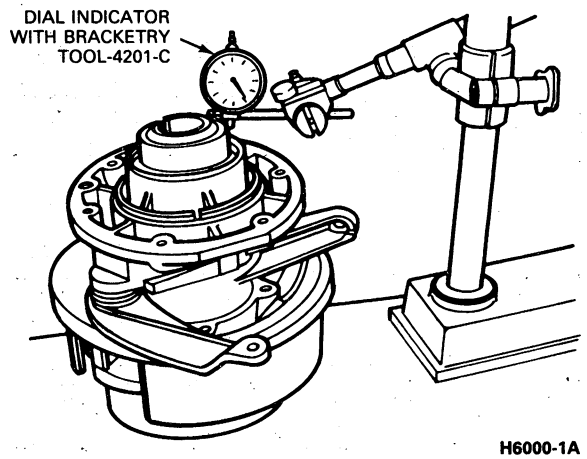
In order to measure mainshaft end play, install the bearing spacer without the O-ring onto the mainshaft.

19. With the case assembly and mainshaft clamped firmly in the vise, screw the hex locknut onto the mainshaft. Tighten the nut to 288-292 N·m (212-216 ft-lb).



H5985-1B

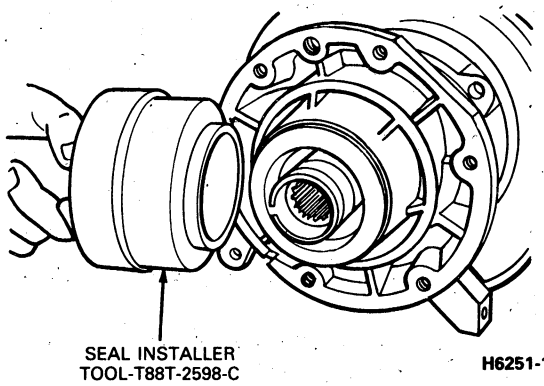
20. Mount a dial indicator between the mainshaft and the case to check end play. Use dial indicator with bracketry TOOL-4201-C or equivalent.



H6000-1A

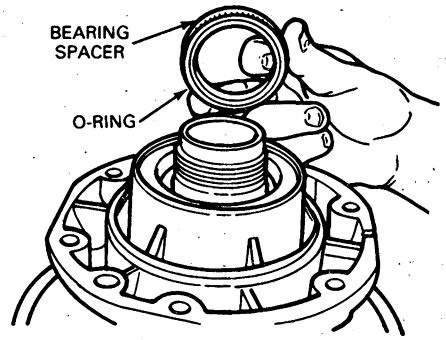
21. While rotating the case assembly on the mainshaft to center the bearings. Apply pressure up and down while taking an end play reading. A reading of 0.0019-0.0039 inches is required. If the reading is not to specification, a thicker or thinner shim must be used.

22. Remove the locknut and the bearing spacer from the shaft.
23. If required, remove the inner bearing cone and add the necessary additional shims to obtain the specified end play.
24. Reinstall the inner bearing cone on the shaft.
25. Coat the outer shell of a new input oil seal with sealer and install it in the bore of the case until it seats inside the bore. The sealing lip of the seal must face inward.



H6251-1A

26. Install a new O-ring in the notch of the bearing spacer and install both parts onto the mainshaft until the space butts against the shoulder of the input bearing.

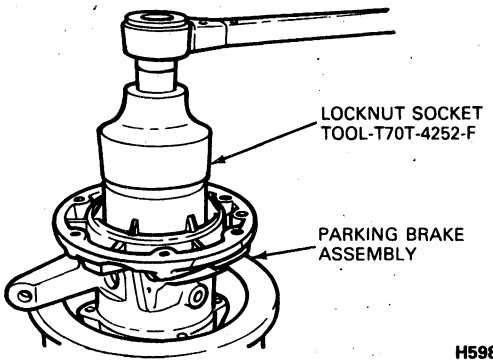


H6252-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

27. Install a new locknut on the shaft, and tighten to 288-292 N·m (212-216 ft-lb).
28. Upset the outer lip of the locknut into the slot in the shaft, using tool T70T-4252-F, or equivalent.



H5985-1B

29. Screw the vent into the case, and tighten it to 12-16 N·m (8-12 ft-lb).
30. Remove the parking brake assembly from the vise.
31. With the parking brake in the as installed position, fill the case with Motorcraft MERCON® E4AZ-19582-B (ESP-M2C166-H) or equivalent through the filler hole. Fill to the bottom of the filler hole, and install and tighten the fill plug to 35-40 N·m (25-30 ft-lb).
32. Reinstall the parking brake assembly as outlined in this Section.

Diagnosis Guides—Transmission Mounted Parking Brake

Transmission Mounted Parking Brake Trouble Shooting Procedure

The following chart can be used when diagnosing transmission mounted parking brake units.

CONDITION	POSSIBLE CAUSE	RESOLUTION
Squeals or groans	Glazed linings	Remove glaze from linings using a file or emery cloth.
	Misalignment of parts	Correct misalignment by tightening any loose brake or drum mounting bolts.
	Dirt in drum	Remove drum and clean out lining dust and dirt.
Scraping noise	Worn out lining	Check for lining worn down to rivets — reline shoes if necessary.
	Bent or misaligned shoe	Check for misaligned shoe, rubbing against drum. Reline shoes if necessary.
Clicks	Excessive clearance	Adjust cable clevis.
	Eccentric or wobbling drum	Inspect drum runout. Also check for worn or loose bearing on mainshaft. Check drum mounting bolts for tightness.
	Excessive linkage friction	Check linkage pivot points for rust, binding, or lack of lubrication.

CH6253-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Grabbing	Brake lubricant or transmission oil on linings	Replace brake linings. Clean oil and excess brake lubricant from brake and drum. Replace faulty oil seal at mainshaft.
Brake does not hold	Excessive clearance prevents complete brake application	Adjust brake lining cable to take up slack in brake linkage.
	Grease soaked linings	Repair source of leak, install new linings.
	Excessive linkage friction	Check for linkage binding, and misalignment. Lubricate all pivot points.
	Worn out linings	Reline brake shoes. Check drum/yoke for scoring and replace if necessary.
Excessive lining wear	Brake drag	Brake lever and camshaft adjustment too tight. Also, inspect for broken or missing springs.
	Rough drum surface or abrasive dirt in drum	Smooth drum with emery paper, or replace drum, if drum is badly scored. **CAUTION: Drum to be replaced if inside diameter exceeds 9.030 inches.**

CH6254-2A

SPECIFICATIONS

PARKING BRAKE CABLE TENSION ADJUSTMENT

Model	Rear Cable Tension ①	
	Lbs.	Newtons
F-150—F-350	350 Min.	1556
Bronco	350 Min.	1556
E-150—E-350	350 Min.	1556

① Check rear cable tension with the parking brake control fully in the last detent position.

CH2506-1H

ROTUNDA EQUIPMENT

Model Number	Description
021-00018	Cable Tension Gauge

CH3535-1B

SPECIAL SERVICE TOOLS

Tool Number	Description
T70T-4252-F	Locknut Socket — 65mm
D80L-1002-L	2 — Jaw Puller
D79L-4621-A	Bearing Cone Remover
D80L-630-6	Step Plate
T77F-1102-A	Bearing Cup Puller
T88T-2598-D	Inner Bearing Cup Installer
T88T-2598-E	Outer Bearing Cup Installer
T88T-2598-C	Oil Seal Replacer
T88T-2598-F	Bearing Replacer
TOOL-4201-C	Dial Indicator with Bracketry

CH6311-1B

TRANSMISSION MOUNTED PARKING BRAKE — TORQUE SPECIFICATIONS

Description	N·m	Ft-Lb
Parking brake case to transmission bolts	34-58	25-43
Driveshaft to output flange	20-27	15-20
Brake backing plate to housing	118-122	87-91
Output yoke flange to brake drum	113-117	83-87
Mainshaft locknut	288-292	212-216
Vent to housing	12-16	8-12
Fill plug	35-40	25-30

CH6255-1B

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GROUP 13 STEERING

(3000)

SECTION TITLE	PAGE
C-300N HYDRAULIC POWER STEERING GEAR—BENDIX	13-48-1
GENERAL STEERING SERVICE	13-01-1
INTEGRAL POWER STEERING GEAR—FORD	13-41-1
POWER STEERING PUMP—C-II	13-53-1
POWER STEERING PUMP—SAGINAW	13-52-1
POWER STEERING PUMP—ZF	13-57-1
STEERING COLUMN—SHIFT ROD WITHIN TUBE	13-06-1
STEERING COLUMN—STRIPPED CHASSIS MODELS	13-07-1
STEERING LINKAGE	13-24-1

SECTION 13-01 General Steering Service

SUBJECT	PAGE
ADJUSTMENTS	
Clear Vision Adjustment	13-01-9
E-150—E-250—E-350	13-01-9
E-150-E-250-E-350, F-150—F-250—F-350, F-Super Duty Chassis	13-01-9
CLEANING AND INSPECTION	
Ford C-II and Saginaw Power Steering Pump	13-01-11
Power Steering Gear	13-01-9
DESCRIPTION	
Steering Gear Model Identification	13-01-1
DIAGNOSIS AND TESTING	
Diagnosis Guides	13-01-9
External Leak Check	13-01-2
Ford C-II Pump	13-01-3
Ford Power Steering Gear	13-01-2
Saginaw Pump	13-01-3
DIAGNOSIS AND TESTING (Cont'd)	
Fitting and O-Ring Leak Inspection	13-01-4
Fluid Level Check	13-01-2
Ford C-II Pump	13-01-2
Power Steering—Preliminary Checks	13-01-1
Power Steering System Test	13-01-5
Power Steering Tests	13-01-4
Pressure, Flow and Leakage Tests	13-01-7
Pump Belt Check	13-01-2
Purging Power Steering System of Air	13-01-8
Devac System	13-01-8
Saginaw Pumps	13-01-2
Start-Up Procedure (After Power Steering Pump or Gear Overhaul)	13-01-9
SPECIFICATIONS	13-01-17
VEHICLE APPLICATION	13-01-1

VEHICLE APPLICATION

Applies to All E-150—350, F-150—350, Bronco and F-Super Duty Series Vehicles.

DESCRIPTION

Steering Gear Model Identification

Steering gears are identified by a service identification tag fastened to the assembly. Tags are located and contain information as shown in Figs. 1 and 2. F-Super Duty Commercial Stripped Chassis and Motor Home Chassis Vehicles use Bendix steering gears (Fig. 2).

DIAGNOSIS AND TESTING

Power Steering—Preliminary Checks

Make the following preliminary checks before servicing the power steering system. Check the fluid level, belt tension and the system for any signs of leakage. If hoses are to be disconnected, label them

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prior to removal so they can be easily identified for re-assembly.

Pump Belt Check

Check and adjust the power steering pump drive belt as described in Section 27-06, Accessory Drive Belt Service, Light Truck Engine Manual.

Fluid Level Check

Ford C-II Pump

1. Run the engine until the fluid reaches normal operating temperatures, 74° to 79°C (165 to 175°F).
2. Turn the steering wheel all the way to the left and right several times. Turn off the engine.
3. Check the fluid level in the power steering reservoir. If the level is low, add Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent. Do not overfill the reservoir.

Saginaw Pumps

NOTE: Fluid level should be checked when performing required maintenance checks.

1. Run the engine until the fluid is at normal operating temperature (approximately 74°-79°C 165°-175°F). Turn the steering wheel all the way from left to right several times. Shut off the engine. Remove the reservoir filler cap and check the fluid level on the dipstick. Level should be between the HOT mark and the end of the dipstick.

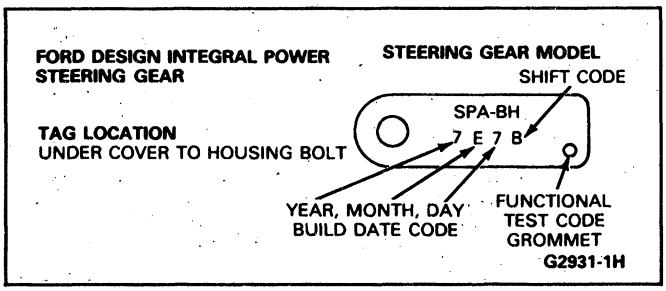


FIG. 1 Steering Gear Identification

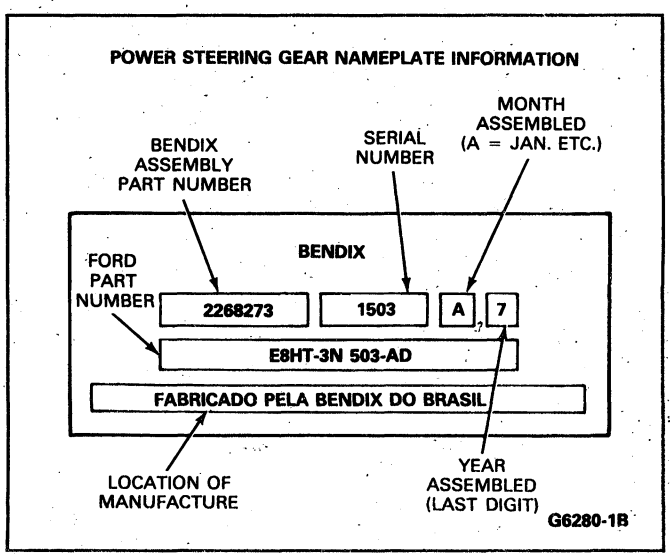


FIG. 2 Steering Gear Identification—Bendix

2. If the fluid level is low, add power steering fluid, Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent to the proper level on the dipstick.
3. When checking the fluid level after the steering system has been serviced, air must be bled from the system.
4. With the engine off, add power steering fluid to the COLD mark on the dipstick.
5. Start the engine, run it at fast idle and re-check the fluid level. Add fluid if necessary to the COLD mark.
6. Bleed the system by turning the wheels from side to side without hitting the stops. Maintain the fluid level just above the internal pump casting. Air must be eliminated from the fluid before normal steering action can be obtained.
7. Return the wheels to the center position and continue to run the engine for two or three minutes. Shut the engine off.
8. Re-check the fluid level as described in Steps 1 and 2. The fluid should be at the HOT mark on the dipstick after the system has stabilized at its normal operating temperature.
9. Road test the vehicle to be certain the steering functions normally and is free from noise.

ZF Pumps

Check the fluid level in the power steering reservoir with the engine off. Use the HOT or COLD markings on the dipstick, depending upon the fluid temperature.

- Use COLD for checking at room temperature, 20°C (70°F).
- Use HOT for normal operating temperatures 80°C (175°F).

The fluid level must show between the ADD and FULL markings on the dipstick. If the fluid is below the ADD mark, add fluid using Mercon®-II or equivalent.

NOTE: After any major power steering system or component overhaul, the system should be purged of old fluid and the oil filter discarded. Install new fluid and a new filter.

External Leak Check

Ford Power Steering Gear

Refer to Fig. 3.

1. With the vehicle engine off, wipe the complete power system dry (gear, pump, hoses, and connections).
2. Check oil level in pump's reservoir and adjust as directed in this Section.
3. Start the engine and turn the steering wheel from stop to stop several times. **Do not hold the wheel against the stops to prevent damage to the pump.**
4. Determine the exact source of leakage by carefully observing the leakage areas shown in Fig. 3.
5. To stop leakage in the sector shaft nut (Point A, Fig. 3), clean any contamination from nut and cover surface. Tighten the nut to 48-61 N·m (35-45 ft-lbs). Replace nut if leakage continues. Check the cover housing for damage.

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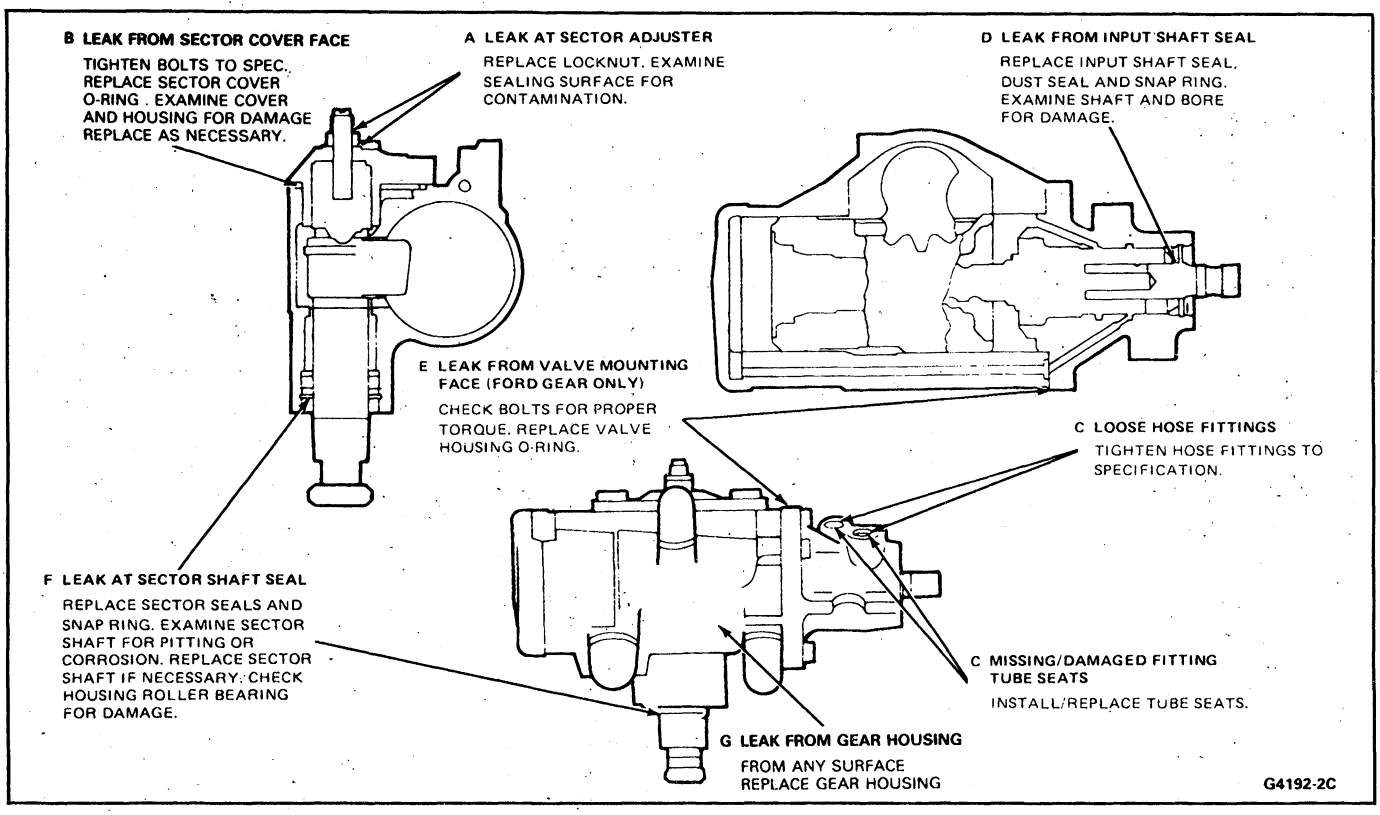


FIG. 3 Oil Leakage Areas—Ford Power Steering Gear

6. If leakage is observed at the sector shaft cover (Point B, Fig. 3), Tighten bolts to 75-94 N·m (55-70 ft-lbs). Replace seal if leakage persists. Examine sealing surfaces for damage when replacing seal.
7. For leakage at hose connections (Point C, Fig. 3) tighten the fitting nuts to specifications. If leakage persists upon tightening, remove the hose. If leakage is due to damaged hose threads, replace the hose. If tube seats are damaged, replace the tube seats. If housing threads are badly stripped, replace the **valve housing only.**
8. To stop leakage at the input shaft seals (Point D, Fig. 3), replace the input shaft seals and snap ring. Check the shaft surface for damage. Check the housing seal bore for damage if leak continues.
9. For leakage at the control valve housing, (Point E, Fig. 3), tighten the control valve housing bolts to 41-62 N·m (30-45 ft-lbs). If leakage continues replace the O-ring seals. Examine sealing surfaces for damage.
10. If leakage is observed in the sector shaft seals (Point F, Fig. 3), replace the sector shaft seals and snap ring. Check the shaft surface for rust or other damage. Check the seal bore and snap ring groove for damage. Check housing roller bearing for damage.
11. If leakage is observed at any point in the housing casting, (Point G, Fig. 3), replace the gear housing.

Saginaw Pump

Refer to Fig. 4.

1. For leakage between the pressure hose fitting nut and hose tube (View A, Fig. 4), tighten the nut to 34-47 N·m (25-34 ft-lbs) torque. If leakage persists, replace the pump pressure fitting and reface the hose tube flare. Replace the O-rings or replace the hose as required.
2. To stop leakage between the discharge fitting and the pump body (View A, Fig. 4), tighten the fitting to 38 N·m (35 ft-lbs) torque. If leakage persists, replace both O-ring seals.
3. For leakage shown in View B, Fig. 3, replace the reservoir O-ring.
4. To stop leakage at the pump driveshaft (View C, Fig. 4), replace the driveshaft seal.
5. For leakage between the return hose and pump inlet line, assure the clamp is located as shown in Fig. 4. Tighten clamp. If leakage is still evident, replace the return hose.
6. If leakage is observed at the bottom of the filler neck or at the inlet line, (Fig. 5), replace the reservoir. If there is leakage at the filler cap, check the oil level and correct as required. If leakage persists, with correct oil level and the cap tight, replace the cap.

Ford C-II Pump

Refer to Fig. 6.

1. For leakage in rotor shaft seal (View A, Fig. 6), replace rotor shaft seal.
2. If the reservoir O-ring seal leaks (View B, Fig. 6), replace O-ring seal.
3. For leakage at the return hose (View C, Fig. 6), tighten return hose clamp.
4. For leakage at the outlet fitting (View D, Fig. 6), tighten the outlet fitting to specification. If leakage continues:
   a. Replace O-ring seals, if leak continues.

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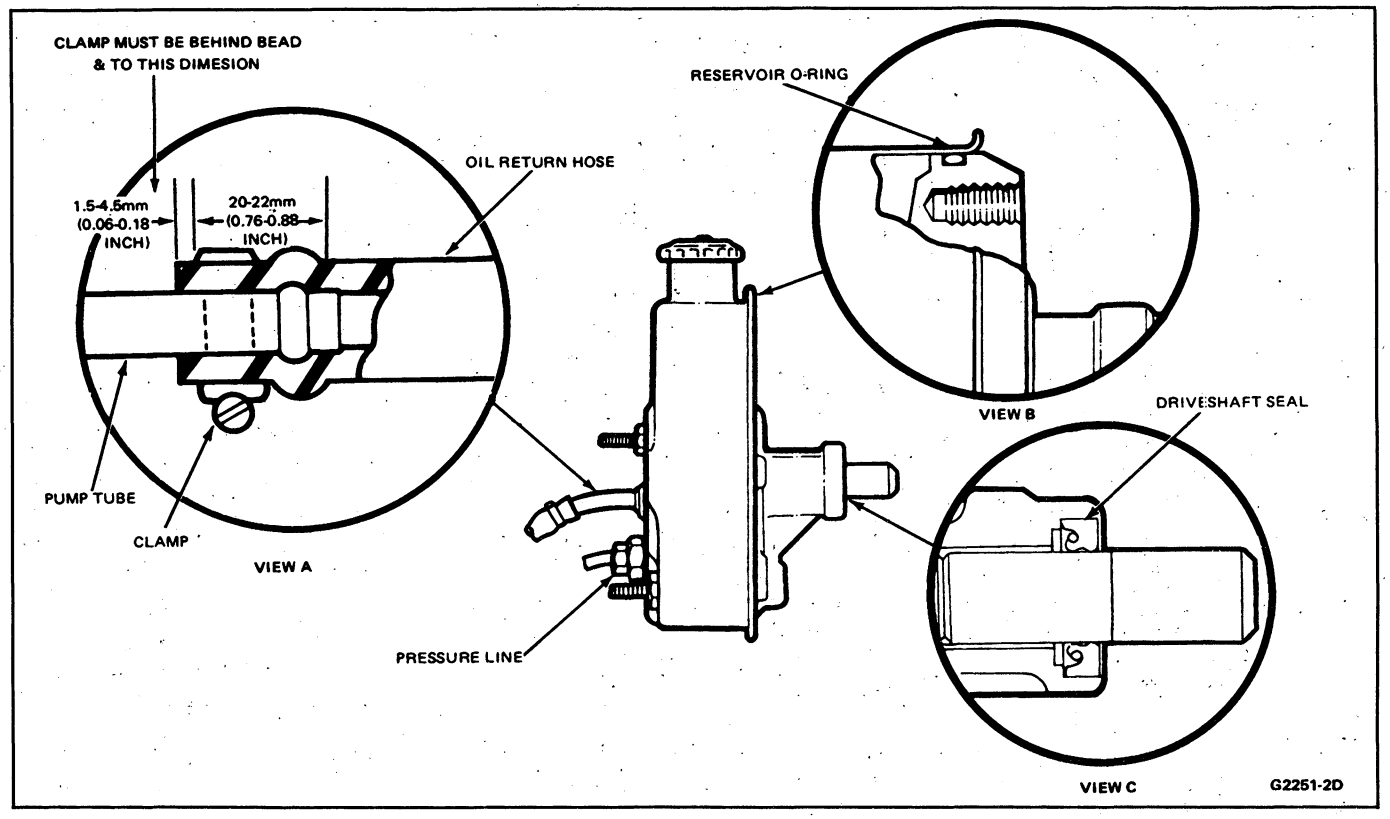


FIG. 4 Reservoir and Pump Leakage Areas—Discharge Line, O-Ring and Driveshaft—Saginaw Power Steering Pump

b. Check for damaged threads (cross-threaded) on the outlet fitting. If threads are damaged, replace outlet fitting. If housing cover threads are stripped, replace the pump housing cover.

5. If pressure hose tube nut leaks (View E, Fig. 6), tighten pressure hose tube nut to specifications. If leak continues:

   a. Replace O-ring, if leak continues;

   b. Replace pressure hose assembly.

6. If leakage occurs at filler cap check the oil level and correct as required. If leakage persists, replace the filler cap O-ring seal. See View F, Fig. 6.

Leak Checks — E Super Duty Striped Chassis Vehicles

1. With vehicle engine of, wipe power steering hoses, steering gear, and reservoir to aid in leak detection.
2. If power steering fluid does not already include dye, mix one teaspoon of oil-soluble aniline dye into power steering fluid and fill reservoir to specification, if necessary.
3. With engine running at 1000-1500 RPM, turn steering wheel all the way to the left and right several times. Do not hold wheels against far right or left position for more than 5 seconds to prevent damage to pump.
4. Shut off engine. Check for leaks.
5. Determine exact source of leakage.

Reservoir Leaks—F-Super Duty Stripped Chassis Vehicles

1. If leakage exists at reservoir ports, check hose clamps for proper installation and reservoir ports for cracks.
2. If leakage exists at reservoir cover/cap or dipstick, check fluid level for overfilling. Siphon excess fluid out with a suction gun to proper level. If leakage persists, provide proper sealing and tightness. If cover/cap remains loose, inspect cover/cap, gasket or reservoir for damaged. Repair or replace as necessary.

Fitting and O-Ring Leak Inspection

Since most fluid leaks occur at the fittings and connections in a power steering hydraulic system, these parts should be checked before any other part is replaced.

1. Clean the outside of the steering gear, the bottom surfaces of the pump, and all lines and fittings. Be sure all dirt, oil, and grease is removed from areas where leaks may exist.
2. Tighten all fittings, using a flare-nut wrench. **Do not tighten the fittings with a standard open-end wrench.** If a properly tightened fitting leaks, replace the tube seat.

Power Steering Tests

The pump flow and pressure tests will confirm or rule out the pump as the cause of steering system problems. Follow the steps below.

Prior to performing the pump flow and pressure tests, the following checks, for conditions which could cause

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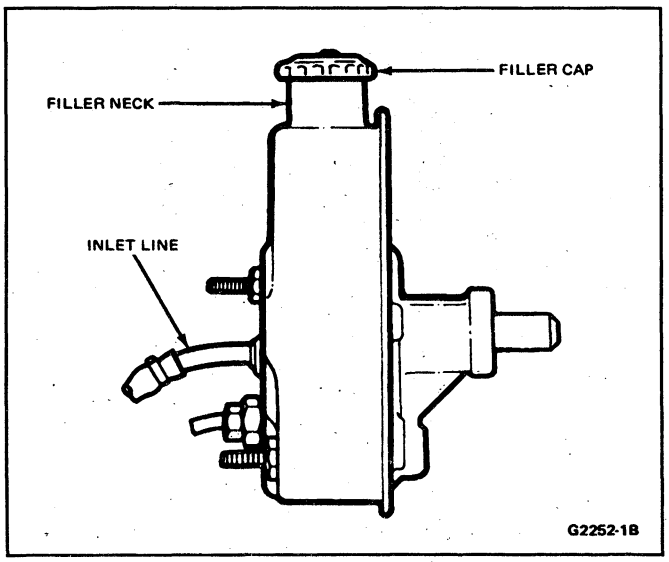


FIG. 5 Reservoir and Pump Leakage Areas—Inlet Line, Filler Neck, and Cap—Saginaw Power Steering Pump

loss of power assist, must be performed and corrective action taken if necessary.

1. Check pump reservoir for proper fluid level.
2. Check tires for correct air pressure.
3. Check pump belt for proper tension.
4. Check pump for correct model and vehicle application.
5. Check for correct size pulleys on pump and engine.
6. Check entire system for damage, replacing parts as necessary.

If the above items are to specifications, or have been corrected, and the loss of assist still exists, test the power steering pump flow and pressure to determine whether the trouble is in the pump, power steering gear, or control valve using the following test equipment.

Test Equipment—E-150-E-350, F-150-F-350, F-Super Duty Chassis Cab and Bronco

1. Engine tachometer
2. Thermometer—-17°-140°C (0° to 300°F).
3. One (1) Power Steering Analyzer, D79L-33610-A or equivalent.
4. One set of adapter fittings.

Power Steering System Test

E-150-E-350, F-150-F-350, F-Super Duty Chassis Cab and Bronco

The following test procedure used in conjunction with the Power Steering Analyzer, D79L-33610-A (Rotunda Model) 014-00207, or equivalent provides a method for checking the complete power steering system. The Flow/Pressure Power Steering Analyzer can be used to determine the cause of hard steering and/or lack of assist problems. The analyzer provides readouts for the following:

CAUTION: Possible contamination of the power steering system fluid may cause permanent damage to gauges and instruments incorporated in the analyzer.

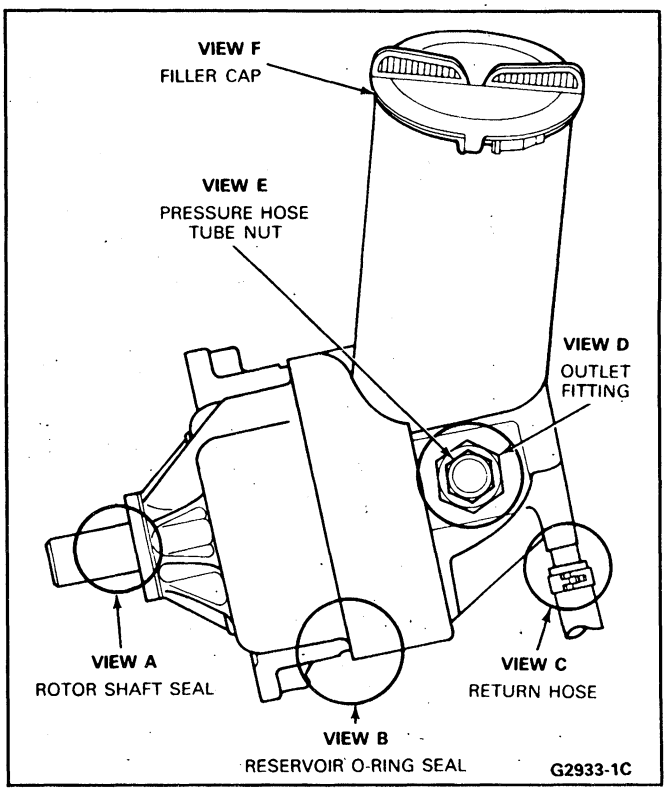


FIG. 6 Filler Cap Fitting and Connection Leakage Areas—Ford CII Pump

1. System backpressure
2. Pump flow
3. Steering gear internal leakage
4. Power steering control valve and cylinder internal leakage

The interpretation of the above readouts will determine which of the following conditions or components are the cause of the problem:

1. Restriction in hoses or fittings
2. Control valve and cylinder
3. Sticking gear valve
4. Inefficient pump cam pack
5. Sticking relief valve
6. Binding in suspension

Test Procedure

Refer to Fig. 7.

1. To connect the analyzer into the steering system, remove the pressure fitting from the pump and connect it into the appropriate adapter of the analyzer.
2. Thread the other adapter of the analyzer into the pump.
3. Connect the analyzer to the adapters and tighten both connections to 15 foot-pounds maximum.

   NOTE: The analyzer may be connected at alternate points between the pump and the gear as illustrated for convenience.
4. Add power steering fluid to the pump if required. Start the engine and run it for approximately two

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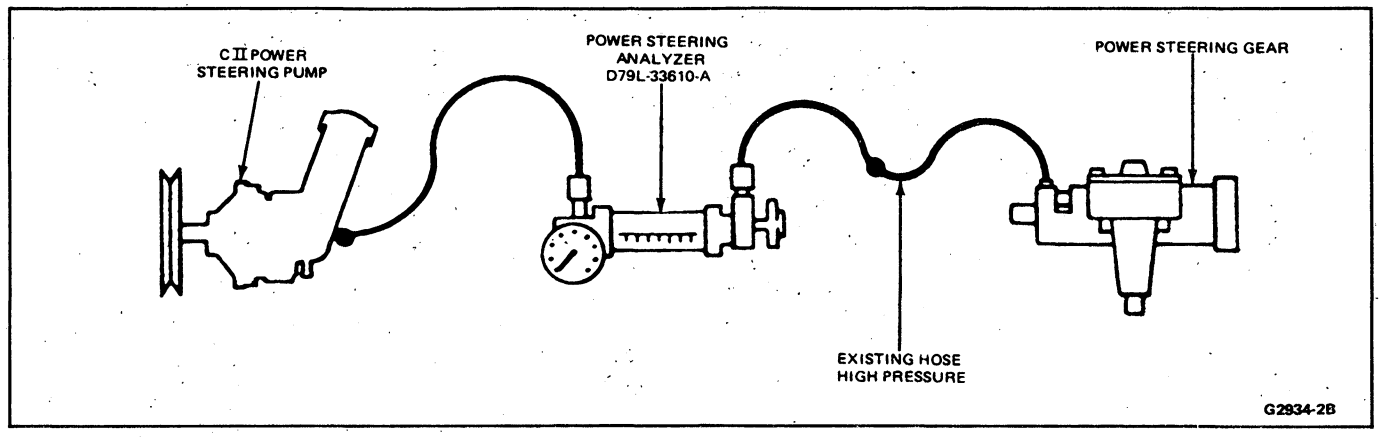


FIG. 7 Power Steering Analyzer Hook Up—Typical Installation

(2) minutes with the idle set at manufacturer's specifications.

5. Record the flow (gallons/min @ 170° ±5°F). If the flow is below two (2) gallons/min., the pump may require repair; however at this point continue the diagnosis. Check specification charts at the end of this Section for flow and relief pressure against the pump model being tested.
6. Record the pressure (psi @ 170° ±5°F). If the pressure is above 150 psi, check hoses for restrictions and check the steering gear.
7. Partially close the gate valve to build up 740 psi for C-II pumps, 620 psi for Saginaw pumps. Record flow (gallons/min. @ 170° ±5°F). If the flow drops to a level lower than the value on Chart I or II, in the Specifications Section at the end of this Section. Disassemble the pump and replace the cam pack. If the pressure plates are cracked or worn, replace them. Continue the diagnosis.
8. Completely close and partially open the gate valve three (3) times. (Do not allow the valve to remain closed for more than five (5) seconds.) Record the pressure (psi). Check Chart I or II in the specifications Section at the end of this part for the pressure specification for the applicable pump model. If the pressure recorded is lower than the minimum specification listed, replace the flow control valve in the pump. If the pressure recorded is above the maximum specification listed, the flow control valve in the pump should be removed and cleaned or replaced.
9. Increase the engine speed from idle to approximately 1500 RPM. Record the flow (gallons/min.). If the flow varies more than one (1) gallon/min. from the flow recorded in Step 5, the flow control valve in the pump should be removed, and cleaned or replaced.
10. Turn (or have someone turn) the steering wheel to the left and right stops. Record the pressure (psi) and flow (gallons/min.) at the stops. The pressure developed at both stops should be nearly the same as the maximum pump output pressure recorded in Step 8. At the same time the flow should drop below .5 gallons/min.

    If the pressure does not reach maximum output or the flow does not drop below specified value, excessive internal leakage is occurring. Remove and disassemble the steering gear and remove the control valve. Replace damaged or broken parts.
11. Turn (or have someone turn) the steering wheel slightly in both directions and release quickly while watching the pressure gauge. The needle should move from the normal backpressure reading and snap back as the wheel is released. If it comes back slowly, or sticks, the rotary valve in the steering gear is sticking. Remove, disassemble and clean the rotary valve. If the system is severely contaminated, both gear hoses, control valve, and pump must be completely disassembled and cleaned before reassembly.

    NOTE: If problem still exits, check ball joints, linkage, "etc.".

    Installation of the analyzer at the pump outlet is preferred (Fig. 7). If it is difficult to attach the analyzer at the pump, it may be installed at any convenient location between the pump and the gear.

Power Steering System Test

F-Super Duty Commercial Stripped Chassis and Motor Home Chassis Vehicles

The pump flow and pressure tests will confirm or rule out the pump as the cause of steering system problems.

Prior to performing the pump flow and pressure test, perform the Preliminary Checks above.

If all preliminary items are to specification, or have been corrected, and the loss of assist still exists, test the power steering pump flow and pressure to determine whether the trouble is in the pump, power steering gear, or the pressure relief valve, as follows:

Preparation for Hydraulic Pressure/Flow Tests

The power steering analyzer is to be used when the power steering system is suspected of erratic steering operation or insufficient power assist, and neither pump or gear have sustained failure or internal damage that may contaminate the fluid in the steering system. The Rotunda Analyzer Kit 014-00230 consists of a pressure gauge, flow meter, shutoff valve, thermometer, hose and adapter attachments.

CAUTION: Possible contamination of the power steering system fluid may cause permanent damage to gauges and instruments incorporated in the analyzer.

1. To connect analyzer into steering system, disconnect pressure line from connector at the pump, as indicated in the diagram (Fig. 9).

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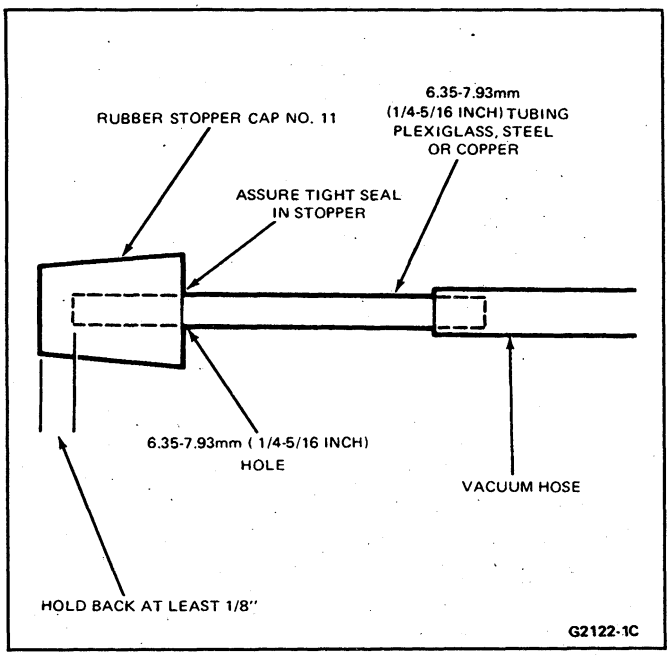


FIG. 8 Power Steering System Purging Tool—For Ford C-II Pump

2. Thread proper adapters to connector and to pressure line.
3. Connect analyzer to adapters. Tighten both connections to proper specification. Ensure analyzer line at shutoff valve end is connected to steering gear end of vehicle power steering system as indicated in the diagram.
4. Fully open shutoff valve, start engine and purge air from power steering system by steering to full left and right turn position several times. Shut off engine and check connections for leaks.
5. Check for proper fluid level at reservoir and add or remove fluid as required. Check for air in system by restarting engine. Partially close shutoff valve and view pressure gauge. If gauge needle vibration is excessive, too much air remains in system. (Repeat Step 4 if necessary).
6. Install thermometer provided with analyzer in reservoir and connect tachometer to engine.

Pressure, Flow and Leakage Tests

Preliminary Test

1. Connect Rotunda Analyzer Kit 014-00230 or equivalent to power steering system as shown in the test diagram. Be sure shutoff valve is fully open.
2. Align front wheels in straight ahead position, and place transmission in NEUTRAL. Engage parking brake.
3. Start engine and partially close pressure line shutoff valve until 5516-6900 kPa (800-1000 psi) is read at pressure gauge. When temperature of power steering fluid in reservoir reaches 50°C (120°F), fully open shutoff valve and turn engine off.

System Back Pressure Check

1. Ensure shutoff is fully open.

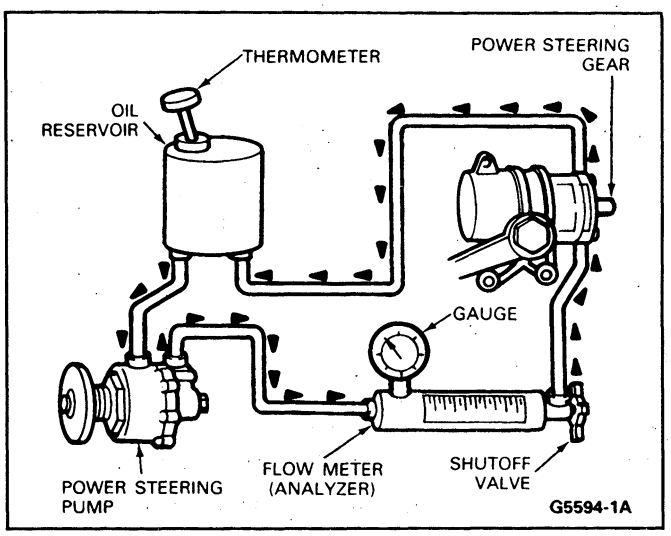


FIG. 9 Test Equipment Connection

2. Start engine and increase speed to 2200 RPM. When fluid temperature reaches 55°C (139°F), record flow rate and pressure.
   a. If flow is below 13.2 liters (3.5 gallons) per minute, verify correct pump is installed. If correct, continue testing to diagnose problem.
   b. If pressure exceeds 552 kPa (80 psi), check lines for kinks or obstructions. If none are found and pressure remains high, continue testing to diagnose problem.

Minimum Pump Flow

1. Decrease engine speed to 600 RPM.
2. Slowly close shutoff valve to increase pressure to 8274 kPa (1200 psi).
3. Record flow rate at 55°C (130°F).
4. If flow rate is below 8.3 liters (2.2 gallons) per minute, verify correct pump is installed. Pump may require repair or replacement, especially if flow at 2200 RPM is also below specification.

Relief Pressure Test—Power Steering Pump

1. With engine at 600 RPM, close shutoff valve and read pressure gauge. Note flow rate is zero. Open shutoff valve quickly after reading gauge pressure and note flow rate returns to normal. If pressure reading is below 140 bar (203 psi) or above 155 bar (255 psi), repair or replacement of relief valve is necessary.

CAUTION: The shutoff valve must not remain closed longer than five seconds r damaged to the pump may result.

2. Allow power steering pump fluid to cool to 55°C (130°F) before resuming testing.
3. With the engine at full governed R.P.M., close the shutoff valve and note the flow reads 0. QUICKLY OPEN THE SHUTOFF VALVE, and note that the flow rate immediately returns to normal. Repeat this test once but do not allow fluid temperature to exceed 95°C (200°F).

If flow rate does not immediately return to normal, pump repair or replacement is indicated.

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Relief Pressure Test and Internal Leakage Test—Power Steering Gear

1. To test the pressure relief valve and internal leakage or the power steering gear, it is necessary to prevent operation of the gear's poppet valves contained in the piston. This can be accomplished by placing a steel block between the axle stop and the adjusting screw (Fig. 10). The block should be a minimum of 25.4 mm (1 inch) thick and long enough to be inserted without danger of pinching fingers. Keep fingers clear of pinch points and be sure block is square to points of contact.

WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN SERIOUS INJURY OR DAMAGE TO THE EQUIPMENT.

2. Check fluid temperature in the reservoir. Thermometer reading should be approximately 55°C (130°F0 at start of the test and shutoff valve on flow meter must be totally open.
3. Turn the steering wheel until the axle stops contact the spacer block. Apply sufficient torque to the steering wheel to assure the power steering gear control valve is completely open in the direction of the turn. At this time the pressure gauge will read the gear pressure relief setting. If the pressure reading is above 1400 kPa (2052 psi) or below 2055 kPa (1950 psi) relief valve adjustment or repair is necessary.

CAUTION: When performing this test, do not hold the torque on the steering wheel for more than 5 seconds beyond the time the pressure relief setting of the gear has been reached. It may damaged the unit or cause the temperature of the oil to raise beyond 93°C (200°F).

4. In order to test steering gear for internal leakage it is necessary to temporarily adjust setting of power steering gear pressure relief bypass valve above that of power steering pump relief valve (Fig. 11).

With the engine stopped, remove plug from valve body using 26mm socket. With plug removed, insert a sufficient member of additional shims into socket portion of a plug to ensure pressure relief bypass valve setting is above that of power steering pump (Fig. 11). Ordinary 3/8 inch O.D. flat washers may be used for shimming. Generally, 3-6mm (1/8-1/4 inch) of additional shimming thickness is sufficient to raise pressure to required level.

5. Run the engine at idle. Turn steering wheel until axle stop contacts spacer block. Refer to illustration under Step 3. Apply a sufficient torque to steering wheel to ensure power steering gear control valve is completely open in direction of turn. Observe the following:
   a. Gauge pressure should read the same as the power steering pump relief pressure. (See Step 1 under "Relief Pressure Test—Power Steering Pump.").
   b. With system pressure at pump relief, read flow meter. If a flow greater than 3.3L (3.5 quarts) per minute is noted, internal leakage is excessive and steering gear requires repair.
6. Repeat Step 5, turning steering wheel in the opposite direction.

NOTE: Remove the shims which were installed in Step 4 from the steering gear pressure relief bypass valve.

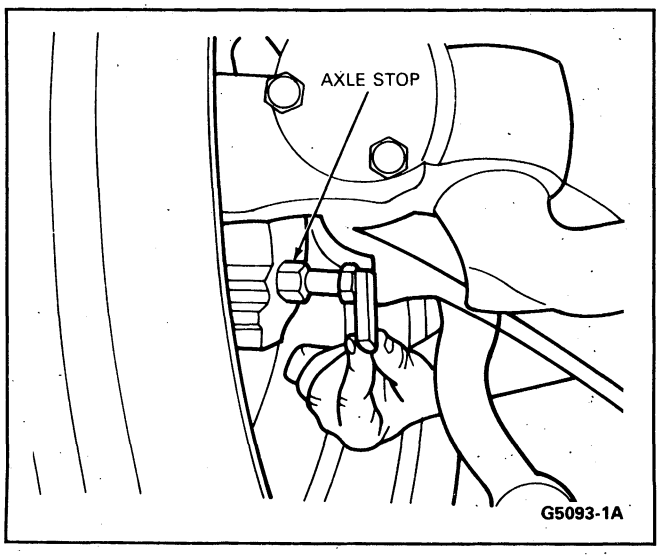


FIG. 10 Checking Pressure Relief

Purging Power Steering System of Air

Air trapped in the power steering system, which causes a whine-type noise between 17-39 km/h (20-45 mph) on light acceleration, can be removed by using a power steering pump air evacuator assembly (DEVAC Tool) or the VACUUM FILL PROCESS.

Devac System

Fabricate a DEVAC purging tool as shown in Fig. 8 for Ford C-II pump, or Fig. 12 for Saginaw pump.

The procedure for removing entrapped air is as follows:

1. Check the pump reservoir oil level to make certain the fluid level is correct (add fluid if low, siphon out fluid if level is above full mark).
2. Insert the rubber stopper end of the air evacuator assembly tightly into the filler tube.
3. Connect a suitable length of hose from the other end of the air evacuator to a distributor machine or air-conditioner vacuum pump. **Do Not Use Engine Vacuum.**
4. Let the engine idle for approximately 15 minutes. Turn steering wheel one full cycle every five minutes. (Do not hit the stops.) This assists in removing air trapped in the system.
5. Disconnect and remove the evacuator and reinstall the filler tube dipstick.

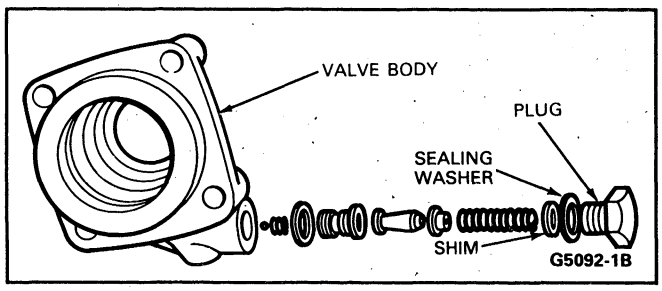


FIG. 11 Shimming Relief Valve

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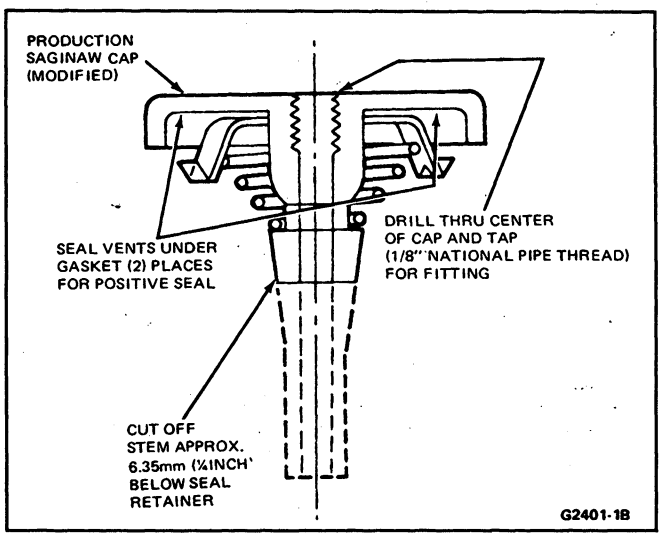


FIG. 12 Modified Pump Reservoir Cap—Saginaw Pump

Start-Up Procedure (After Power Steering Pump or Gear Overhaul)

Upon initial engine start-up after a power steering pump or gear overhaul (particularly the pump), there is very frequently much noise and aeration. This is due to air trapped in the overhauled unit which mixes with the surging fluid and causes aeration. The problem can be minimized if the following procedure is used:

1. Disconnect the coil wire.
2. Fill the reservoir.
3. Crank the engine with the starter and continue adding fluid until the level remains constant. Be careful to avoid prolonged cranking as the battery may be drained and the starter damaged.
4. Rotate the steering wheel approximately 30 degrees each side of center while continuing to crank the engine.
5. Re-check the fluid level and fill as required.
6. Reconnect the coil wire.
7. Start the engine and allow it to run for several minutes.
8. Rotate the steering wheel from stop to stop.
9. Shut off the engine and re-check the fluid level—add as required.

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in diagnosing steering system problems. For additional diagnosis procedure, refer to Section 19-01, Roadability.

NOTE: Refer to Specification Guide for correct lubricant.

ADJUSTMENTS

Clear Vision Adjustment

E-150—E-250—E-350

Steering wheel misalignment (improper clear vision) on F-Super Duty Commercial Stripped Chassis and Motor Home Chassis vehicles can be corrected only by removing and recentering the steering wheel. Because the steering linkage has only one tie rod adjustment, improper clear vision cannot be corrected by adjustment of the steering linkage or suspension components. If improper clear vision is attempted to be corrected by adjustment of the tie-rod sleeve, grossly misadjusted toe may result.

E-150-E-250-E-350, F-150—F-250—F-350, F-Super Duty Chassis Cab and Bronco

Steering wheel clear vision is preset at assembly prior to toe adjustment and cannot be adjusted by removing the steering wheel and arbitrarily mis-indexing the wheel and center shaft alignment. Improper clear vision is an indication that toe is incorrect.

Refer to Section 13-06, Steering Column—Shift Rod Within Tube and Section 14-01, General Suspension Service for the clear vision adjustment.

CLEANING AND INSPECTION

Power Steering Gear

Cleaning

Disassembly and assembly of the steering gear and the sub-assemblies must be made on a clean workbench. As in repairing any hydraulically-operated unit, cleanliness is of utmost importance. The bench, tools, and parts must be kept clean at all times. Thoroughly clean the exterior of the unit with a suitable solvent and, when necessary, drain as much of the hydraulic fluid (or gear grease) as possible. Handle all parts very carefully to avoid nicks, burrs, scratches and dirt, which could make the parts unfit for use.

Do not clean, wash or soak seals in the cleaning solvent.

Inspection

1. Check input shaft bearing for damage. Replace if necessary.
2. Inspect the valve housing for scoring or burrs.
3. Inspect the tube seats in the pressure and return ports in the housing for nicks, etc. If necessary, replace tube seats.
4. Check all fluid passages for obstruction or leakage.
5. Inspect the steering gear housing for cracks, stripped threads, and mating surfaces for burrs. Inspect the piston bore of the housing or scoring. Check roller bearings for damage. If necessary, replace the housing.
6. Check the input shaft bearing after installation to be sure that it rotates without binding or roughness.
7. Check the piston rack teeth and sector shaft teeth for nicks and burrs.

Flushing

Should it be necessary to replace an inoperative power steering pump when fluid contamination could have occurred, flushing the steering gear is required when installing the repaired pump.

1. Remove the power steering pump and remove the pulley as outlined in Section 13-52, Power Steering Pump—Saginaw, or 13-53 Power Steering Pump C-II.
2. Install the pulley on the repaired pump. Install the pump and connect only the pressure hose to the pump.

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STEERING SYSTEM PROBLEMS

CONDITION	POSSIBLE CAUSE	RESOLUTION
Power steering pump leaks.	1. Fluid, cap and dipstick.	1. Check for indications of false leakage — overfilled reservoir, improperly installed, damaged or lost cap or dipstick.
	2. Loose or damaged hose connections.	2. Repair or replace as required.
	3. Leakage between reservoir and housing.	3. Repair or replace as required.
	4. Leakage at pump shaft seal area.	4. Replace shaft seal or pump.
Noise in steering column.	1. Steering column cover interference.	1. Adjust or reposition as required.
(Squeak or creak)	2. Steering column out of alignment.	2. Align or adjust as required.
	3. Lack of lubrication where horn brush contacts rub plate of steering wheel.	3. Lube or adjust as required.
	4. Loose steering column mounting bolts.	4. Tighten to specification.
(Clunk)	5. Flex coupling bottoming.	5. Align or adjust as required.
	6. Loose pot coupling to steering column bolt.	6. Tighten to specification.
	7. Improper steering gear mesh load.	7. Readjust to specification.
Excessive Steering Effort	1. Improper oversized tires.	1. Install correct tire and wheel combination.
	2. Tires not uniform.	2. Install correct tire and wheel combination.
	3. Tire pressure.	3. Adjust air pressure in tires.
	4. Misaligned flexible coupling (if so equipped) to gear interference.	4. Align or adjust as required.
	5. Steering wheel to column interference.	5. Align or adjust as required.
	6. Steering column alignment.	6. Align or adjust as required (E-150 — E-350).
	7. Steering linkage or front axle spindle pins for a binding condition or lack of lubrication.	7. Lube, inspect, adjust or replace as required.
	8. Bind in front axle spindle thrust bearings.	8. Lube, inspect, adjust or replace as required.
	9. Steering gear adjustment.	9. Adjust to specification.

CG3859-2C

3. Place the fluid return line from the gear in a suitable container and plug the reservoir return tube.
4. Fill the reservoir with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C23-F) or equivalent on Ford C-II pumps and on Saginaw Pumps.
5. Disconnect the coil wire to prevent the engine from starting and raise the front wheels off the ground.
6. While approximately two quarts of steering gear fluid are being poured into the reservoir, turn the engine over using the ignition key. At the same time, cycle the steering wheel from stop to stop. Be careful to avoid excessive cranking as the battery will be drained and the starter damaged.
7. As soon as all of the lubricant has been poured in, turn off the ignition key, and attach the coil wire.
8. Remove the plug from the reservoir return tube, and attach the return hose to the reservoir.
9. Check the reservoir fluid level. If low, add fluid to the proper level. Do not overfill.
10. Lower the vehicle.

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Excessive Steering Effort (Cont'd.)	10. Power steering pump belt loose, glazed or broken.	10. Inspect, adjust belt tension or replace as required.
	11. Power steering pump fluid level and possible leak in system.	11. Add fluid, tighten connections and correct as necessary.
	12. Power steering pump pressure and flow below specification.	12. Conduct pump flow and relief pressure tests and adjust or repair as necessary.
	13. Air in power steering system.	13. Add fluid, tighten connections and bleed system.
	14. Contaminated fluid, incorrect fluid.	14. Replace with correctly specified fluid.
	15. Obstruction within steering gear or lines (including bent or kinked steel tubing).	15. Inspect, remove obstruction(s) and repair or replace as required.
	16. Steering gear valve binding or gear out of adjustment (Integral Power Steering).	16. Inspect, repair or replace as required (Meshload Only).
	17. Excessive internal gear leakage.	17. Inspect, repair or replace as required.
Wanders Side to Side — Loose Steering	1. Vehicle overloaded or unevenly loaded.	1. Correct as required.
	2. Improper (mismatched) tires and wheels.	2. Install correct tire and wheel combination.
	3. Tire pressure.	3. Adjust air pressure in tires.
	4. Loose steering gear mounting.	4. Adjust to specification.
	5. Front and rear suspension components for looseness, wear or damage.	5. Tighten or replace as necessary.
	6. Steering linkage connections for looseness, wear or damage.	6. Tighten or replace as necessary.
	7. Loose wheel lug nuts.	7. Tighten to specifications.
	8. Spindle pin (king pin) binding.	8. Lubricate suspension.
	9. Front wheel bearing adjustment.	9. Adjust to specification.
	10. Flexible coupling fractured.	10. Replace as required.
	11. Incorrect toe setting.	11. Set to specifications.
	12. Steering gear conditioning and adjustments.	12. Adjust to specification.

CG3860-2C

11. Start the engine and cycle the steering from stop to stop to expel any trapped air from the system.

Ford C-II and Saginaw Power Steering Pump

Flushing

When contamination is noted while overhauling the gear, it will be necessary to flush the power steering pump.

1. Leave all hoses connected, except the pressure line at the gear.
2. Place the pressure line in a suitable container.
3. Fill the reservoir with power steering fluid, Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent on Ford C-II and Saginaw Pumps.
4. Disconnect the coil wire to prevent the engine from starting.
5. While approximately two quarts of the steering gear fluid are being poured into the reservoir, engage the starter.

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Pulls To One Side	1. Check tire sizes of each wheel to be sure they are the same size and type.	1. Install correct tire and wheel combination.
	2. Tire pressure.	2. Adjust air pressure in tire.
	3. Vehicle unevenly loaded.	3. Correct as required.
	4. Improper brake operation or adjustment.	4. Inspect, adjust and correct as required.
	5. Front wheel bearing adjustment or faulty rear wheel bearing.	5. Adjust or replace as required.
	6. Broken or sagging springs on front and/or rear suspension.	6. Inspect and replace as required.
	7. Loose steering gear mountings.	7. Tighten to specification.
	8. Loose, worn or damaged steering linkage.	8. Tighten and replace as required.
	9. Bent spindle or spindle arm.	9. Inspect and replace as required.
	10. Bent rear axle housing and/or loose, worn or damaged spring, shock absorber and suspension arm attaching points.	10. Inspect, tighten and replace as required.
	11. Frame or underbody out of alignment.	11. Correct as required.
	12. Front wheel alignment.	12. Set to specification.
	13. Belted tires (misaligned belts).	13. Replace as required.
	14. Steering gear valve binding or out of adjustment.	14. Clean and replace as necessary.
Returnability Poor	1. Tire pressure.	1. Adjust air pressure in tires.
	2. Steering column alignment.	2. Align or adjust as required.
	3. Steering linkage for a binding condition or lack of lubrication.	3. Lube, adjust or replace as required.
	4. Spindle pin (king pin) binding.	4. Lubricate Suspension.
	5. Tight front axle spindles.	5. Lube, correct as required.
	6. Bind in front axle spindle bolt thrust bearings.	6. Lube, correct as required.
	7. Set toe to specifications.	7. Adjust as required.
	8. Steering gear adjustment.	8. Adjust to specification.
	9. Kinked return hose or tube.	9. Inspect and repair or replace as required.
	10. Obstruction with steering gear or lines.	10. Inspect, remove obstructions and repair or replace as required.

CG3861-2B

6. As soon as all the fluid has been poured in, turn off the ignition.
7. Attach the pressure hose at the gear.
8. Check the reservoir fluid level.
9. Crank the engine with the starter and continue adding fluid until the level remains constant. Lower the vehicle and attach the coil wire.
10. Start the engine and cycle the steering wheel from stop to stop to expel any air from the system.

Cleaning

Wash all parts except seals in a chlorinated solvent and dry with compressed air.

Inspection (Ford C-II Pump)

To determine when to replace power steering pump components follow these guidelines. Some components must be replaced regardless of condition.

1. Re-use the outlet fitting if the corners are not rounded and the threads intact.

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Shaking Shift Lever — Manual Steering Column	1. Check engine for proper tuning.	1. Tune engine.
	2. Check the steering column mounting, the adjacent sheet metal area, the shift tube bushing and the shift linkage.	2. Repair or replace the column and/or components as required.
	3. Check engine and transmission insulators and mounts for alignment and movement.	3. Repair, replace or adjust as required.
	4. Check transmission shift lever(s) detent torque loading.	4. Repair or replace transmission shift components as required.
Clear Vision Complaint — Steering Wheel Spokes Obscure View of Instrument Panel with Wheels in Straight Ahead Position	E-150 — E-250 — E-350	
	1. Steering wheel mis-indexed on steering column.	1. Remove steering wheel and align on column.
	2. Toe out of adjustment.	2. Adjust toe setting per Section 14-01, General Suspension Service.
	3. Damaged or twisted sector shaft.	3. Replace sector shaft.
	F-150 — F-250 — F-350 and Bronco	
	1. Toe out of adjustment.	1. Adjust toe setting per Section 14-01, General Suspension Service.
	2. Damaged or twisted sector shaft.	2. Replace sector shaft.
Power Steering	1. Check belt for proper tension or glazing.	1. Tighten or replace belt as required.
Pump Noisy	2. Low fluid level and possible leakage.	2. Refill to specified level. Purge air from system. Check for leaks. Repair as required.
Swish Type Noise	3. Fluid flow into the bypass valve of the pump valve housing with fluid temperature below 54°C (130°F).	3. Normal noise.
Whine Type Noise	4. Aerated fluid or cam contour damaged.	4. Purge system of air. If condition not resolved, replace rotor assembly.
	5. Check valve cover "O"-ring seal.	5. Replace valve cover "O"-ring seal.
Clicking Mechanical Type Noise	6. Pump slippers too long, excessive wear of pumping elements, excessive slipper to slot clearance, or out of square slipper springs.	6. Replace rotor assembly.
Chatter Type Noise	7. Chipped corners on rotor outside diameter or distorted slipper spring.	7. Replace rotor assembly.

CG3862-2B

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Other Cause of Noise	8. Improper assembly of components such as slippers.	8. Rebuild pump and replace components as required.
	9. Imperfections on rotor outside diameter or rotor end surface.	9. Replace rotor assembly.
	10. Damaged rotor splines.	10. Replace rotor assembly.
	11. Hairline crack on cam inner surface.	11. Replace rotor assembly.
	12. Interference between rotor and cam.	12. Replace rotor assembly.
	13. Excessively worn or scored pumping elements and pressure plates.	13. Replace rotor assembly and pressure plates.

CG3863-2B

2. Replace all seals.
3. Re-use the reservoir assembly if the reservoir seal areas are not damaged. Check for a broken or missing baffle.
4. Re-use the housing or housing assembly if the O-ring and and snap ring surfaces are not damaged.
5. Re-use the rotor and cam assembly if wear is limited to removal of the phosphate coating on the cam contour. Do not disassemble the unit. Push the rotor part way through the cam insert, being careful not to dislodge the slippers and springs. Check the cam inside diameter for scoring or burring. Check the rotor faces and outside diameter for scoring and chipping. Do not repair or refinish the upper and lower pressure plates, cam or rotor assembly. If wear or burring is evident, replace them with new components.
6. Install a new rotor and cam assembly if the slippers are worn.
7. Re-use the rotor shaft if the thrust faces, bushing diameter and shaft seal diameter are not excessively worn or scored.
8. Re-use the housing and bushing assembly if all the threaded holes are not damaged beyond repair, and the bushing diameter is not scored or worn, 0.0127mm (0.0005 inch) over the 17.50mm (0.6891 inch) maximum. Repair the threaded holes by drilling out the damaged threads and installing helicoil inserts. If the bushing is scored or excessively worn, install a new housing and bushing assembly.
9. Re-use the valve body if valve bore is free of nicks, scoring and the valve screen is clean. Valve must fall freely in valve bore. Replace valve housing and or valve if valve sticks in bore.

Inspection (Saginaw Pump)

The following describes the components of the power steering pump which must be replaced regardless of condition and how to determine when other components should be replaced:

All seals must be replaced with new components except the rotor shaft seal which should be reused unless it was leaking.

The flow control valve assembly may be reused unless it is damaged (score marks, wear, burrs, etc).

The housing assembly may be reused if there is no damage (scratches, burrs, etc.) at machined surfaces, especially mating surfaces on O-ring seats.

If the shaft bushing in the pump housing is scored or excessively worn the pump housing assembly must be replaced.

The pressure plate may be reused unless the V-shaped notches at the edges of the discharge ports are damaged or other visual damage (cracks, etc.) is evident. These notches must be clean and undamaged if pump noise is to be avoided, as they cushion the hydraulic shock when each vane passes the port.

The cam ring may be re-used if it is not damaged (score marks, cracks, etc.).

The cam ring is treated with Lubricant which leaves a dull gray-black finish on the wear surface. A wavy grain appearance inside the cam ring is normal.

The vanes should be removed from the rotor and examined for wear; the vanes and rotor may be reused if not damaged.

The rotor shaft may be reused if there is no damage (score marks, excessive wear, etc.) at splines, keyway, bearing and seal surfaces.

Inspection (ZF Pump)

1. Thoroughly clean all pump and reservoir parts (except seals) with solvent. Wipe dry with a lint-free cloth.
2. For disassembly and assembly procedures, refer to Section 13-57, Power Steering Pump-ZF.

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AUTOMATIC TRANSMISSION SELECTOR SHIFTER LEVER HARD TO ROTATE (EXCEEDING 37.8N OR 8.5 LBS. AT SHIFT LEVER KNOB)

TEST STEP	RESULT ▶	ACTION TO TAKE
1 LUBRICATE SHIFT LINKAGE • Lubricate the shift linkage with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent.	(OK) ▶ (OK) ▶	GO to **6.** GO to **2.**
2 VISUAL INSPECTION • Inspect for bent rods or levers, damaged bushings.	(OK) ▶ (OK) ▶	GO to **3.** REPLACE bent or damaged rods, levers, bushings and/or as required. GO to **6.**
3 CHECK SHIFT EFFORT • Disconnect linkage at the adjusting stud and check shift effort at shift lever knob. Shift effort must be below 8.9N (2 lbs.)	Shift effort below 8.9N (2 lbs.) (OK) ▶ Shift effort at or above 8.9N (2 lbs.) (OK) ▶	GO to **5.** GO to **4.**
4 BEARING RETAINER FIT • Remove the lower bearing retainer and check the rotational fit to shift tube.	Bearing retainer rotates freely in shift tube (OK) ▶ Bearing retainer binds during rotation (OK) ▶	GO to **4a.** REPLACE shift tube assembly or retainer. GO to **6.**
4a SHIFT SOCKET FIT • Check the rotational fit between the shift socket and flange.	Shift socket rotates freely (OK) ▶ Shift socket binds during rotation (OK) ▶	GO to **4b.** REPLACE shift socket and/or flange as required. GO to **6.**
4b AXIAL CLEARANCE • Check for 0.127mm (0.005 inch) minimum axial clearance between socket and flange.	Clearance at or below 0.127mm (0.005 inch) (OK) ▶ Clearance above 0.127mm (0.005 inch) (OK) ▶	DISASSEMBLE the steering column and REPLACE the shift linkage as required. REFER to Section 13-06, Steering Column. REPLACE the outer tube assembly. GO to **6.**

CG3129-2E

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AUTOMATIC TRANSMISSION SELECTOR SHIFTER LEVER HARD TO ROTATE (EXCEEDING 37.8N OR 8.5 LBS. AT SHIFT LEVER KNOB) (Cont'd.)

TEST STEP	RESULT ▶	ACTION TO TAKE
5 TRANSMISSION SHIFT EFFORT		
• Attach the fish scale to the adjusting stud. Measure the force required to shift the transmission.	Shifting force less than 86.7N (19.5 lbs.) ▶	INSTALL nut on the adjusting stud and ROTATE stud by hand. If stud does not rotate freely, REMOVE 'c'-clip and LUBE under stud. GO to **6**.
	Shifting force greater than 86.7N (19.5 lbs.) ▶	GO to **5a**.
5a RECHECK SHIFT EFFORT		
• Disconnect the shift rod at the transmission lever. Attach a fish scale to the transmission lever and test shift effort.	Shifting force less than 77.8N (17.5 lbs.) ▶	REMOVE the bellcrank support bracket from the transmission and LUBE the bushing thoroughly. CHECK all other bushings for hard rotational effort. GO to **6**.
	Shifting force greater than 77.8N (17.5 lbs.) ▶	Condition is associated with transmission. REFER to Section 16-10 General Manual Transmision Service under Diagnosis.
6 VERIFY CONDITION		
• Replace any bushing or 'c'-clip that was disconnected and adjust linkage per appropriate section in Group 16. Retest for correct shift effort.		

CG3685-2B

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SPECIFICATIONS

STEERING TORQUE LIMITS
F-150 — F-250 — F-350, F-Super Duty — E-150 — E-250 — E-350 AND BRONCO

Description	Model	Torque (ft-lbs)	Torque N·m
Steering Gear to Frame — Power and Manual	All	44-66	68-88
Pitman Arm to Steering Gear	All	170-230	230-310
Drag Link/Tie Rod End Studs	All	52-74	70-100
Linkage Adjusting Sleeve Clamp	F-150 — F-350, E-150 — E-350, Bronco	29-41	40-57
Linkage Adjusting Sleeve Clamp	F-Super Duty	60-93	81-126
Power Steering Support Bracket to Engine or A/C Bracket	E-150 — E-350 (8 Cyl.)	30-45	41-61
Power Steering Adjusting Bracket to Support Bracket	E-150 — E-350 (8 Cyl.)	30-45	41-61
Power Steering Pump to Adjusting Bracket	E-150 — E-350 (All)	30-45	41-61
Power Steering Bracket to Engine	E-150 — E-350 (6 Cyl.)	40-60	55-61
Power Steering Adjusting Bracket to Brace	E-150 — E-350 (6 Cyl.)	30-45	41-61
Power Steering Cooler to Frame Bracket	E-150 — E-350 (All)	11-16	15-21
Power Steering Pressure Hose (Pump) (Gear)	E-150 — E-350 (All)	35-34	34-46
Power Steering Pressure and Return Hose	All	20-30	27-41
Flange and Insulator Assembly to Steering Gear	F-150 — F-350, Bronco	25-34	34-46
Coupling Shaft to Steering Shaft	F-150 — F-350, Bronco	35-50	61-80
Flange and Insulator to Steering Column	E-150 — E-350	14-21	18-28
Steering Wheel to Steering Shaft	All	30-42	41-56
Support Bracket to Steering Column	All	13-20	18-27
Steering Column (Support Bracket to Pedal Bracket)	F-150 — F-350	13-27 8-20	18-37 11-27
Steering Column (Floor Opening Cover Plate to Floor)	F-150 — F-250 — F-350 E-150 — E-250 — E-350	9-13 8-20	12-18 11-27
Steering Column (Floor Opening Cover Plate Clamp)	F-150 — F-350, Bronco	8-18	11-24
Description	**Model**	**Torque (ft-lbs)**	**Torque N·m**
Shroud	All	10-15	1.1-1.7
Ignition Switch to Steering Column	All	40-60	4.5-7.3
Flange and Insulator Assembly to Steering Gear	E-150 — E-350	20-35	27-47

CG1766-2Q

POWER STEERING PUMP SPECIFICATIONS — FLOW AND PRESSURE — CHART I — FORD CII PUMP

Pump Model	Minimum Flow @ 740 PSI		Minimum Pressure Relief		Maximum Pressure Relief	
	Liters/Minute 76°C + −15°C	Gallons/Minute 170°F + 5°F	kPa	PSI	kPa	PSI
HBC-HG	5.3	1.4	8960	1300	10542	1530
HBC-HN	5.7	1.5	9300	1350	10542	1530

CHART II — SAGINAW PUMP

Pump Model	Minimum Flow @ 620 PSI		Minimum Relief Pressure		Maximum Relief Pressure	
	Liters/Minute 76°C + 15°F	Gallons/Minute 170°F + 5°F	kPa	PSI	kPa	PSI
HBA-HA	6.8	1.8	8620	1250	9997	1450

CG2935-2G

SPECIAL SERVICE TOOLS

Number	Description	Application
T63L-8620-A	Belt Tension Gauge	Universal
D79L-33610-A	Power Steering Pump Analyzer	All Vehicles

CG3681-2D

ROTUNDA EQUIPMENT

Number	Description
014-00207	Power Steering Analyzer
014-00230	Power Steering Analyzer

CG3682-1C

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SECTION 13-06 Steering Column—Shift Rod Within Tube

SUBJECT	PAGE
ADJUSTMENTS	
Automatic Transmission Selector Indicator (PRND21) (PRN©D1) and (PRN©21)	13-06-2
Ignition Switch Adjustment	13-06-2
Steering Column Alignment	13-06-2
E-150—E-350	13-06-2
F-150—F-350, Bronco and F-Super Duty	13-06-2
Steering Wheel Alignment For Spoke Position—Clear Vision	13-06-2
E-150—E-350	13-06-3
F-150—F-350, Bronco and F-Super Duty	13-06-2
DESCRIPTION	
Steering Column	13-06-1
DIAGNOSIS AND TESTING	13-06-1
DISASSEMBLY AND ASSEMBLY	
Non-Tilting Steering Column	13-06-12
Non-Tilting Steering Column Flange and Locking Mechanism Subassembly	13-06-15
Steering Column Lower Bearing Retainer Subassembly	13-06-18
Steering Shaft and Anti-Rattle Clips	13-06-18
Non-Tilting Column	13-06-18
Tilt Column	13-06-18
Tilt Column	13-06-15
Tilt Mechanism Upper Shaft, Bearings, and Flange Sub-Assembly	13-06-16

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Column Lock Actuator and Steering Wheel Lock Pin	13-06-7
Floor Opening Cover Plate	13-06-7
Ignition Lock Cylinder Assembly (With Key)	13-06-8
Ignition Lock Cylinder (Without Key)	13-06-8
Ignition Lock Drive Gear	13-06-11
Lower Bearing Retainer	13-06-7
F-150—F-350, Bronco and F-Super	13-06-7
Manual Transmission Key Release Button and Lever	13-06-11
Steering Column	13-06-4
E-150—E-350	13-06-6
F-150—F-350, Bronco and F-Super Duty	13-06-4
Steering Intermediate Shaft and Flex Coupling	13-06-4
F-150—F-350, Bronco	13-06-4
Steering Wheel	13-06-3
Upper Components—Steering Column: Upper Shaft Bearing, Flange, and Shift Socket/Flange Extension	13-06-7
SPECIFICATIONS	13-06-19
VEHICLE APPLICATION	13-06-1

VEHICLE APPLICATION

Applies to F-150—F-350, E-150—E-350, Bronco and F-Super Duty Vehicles.

DESCRIPTION

Steering Column

F-150—F-350, Bronco and F-Super Duty

The F-150—F-350, Bronco and F-Super Duty vehicles are equipped with a slip-joint coupling shaft which attaches between the steering gear and the steering column lower shaft. The column itself features a concentric outer tube, internal shift tube, and steering shaft. The components are designed to collapse in the event of an accident.

Once the column is collapsed, a new column and support bracket must be installed.

E-150—E-350

The E-150—E-350 vehicles are equipped with a steering column which attaches the steering shaft directly to the steering gear. The column design features a concentric outer tube, internal shift tube, and steering shaft. The components are designed to collapse in the event of an accident.

Once the column is collapsed a new column and support bracket must be installed.

E-150—E-350, F-150—F-350, Bronco and F-Super Duty

Four steering column versions are offered. There are two fixed wheel (non-tilting) columns; manual 4-speed floor shift, and automatic column shift. There are two tilt columns; manual 4-speed floor shift and automatic column shift. The tilt columns feature five driving positions (two up, two down, and a center position). Both fixed and tilt columns feature an emergency warning flasher control, a turn signal indicating switch with lane change position, and are equipped with an anti-theft device which locks the steering system and, on automatic transmission equipped vehicles, the transmission linkage.

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service, for diagnostic and testing procedures.

ADJUSTMENTS

NOTE: If the flexible coupling has been driven in a non-flat condition for more than 10,420 km (12,000 miles), it is recommended that it be replaced.

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Steering Column Alignment

F-150—F-350, Bronco and F-Super Duty

There is no alignment adjustment of the steering column and coupling shaft. Alignment is maintained by the slip-joint coupling shaft attaching the steering column to the steering gear. If misalignment exists, check for indications of damage, such as bent or displaced components. For proper installation follow procedure described in this Section.

E-150—E-350

Any stress or misalignment in the steering column tube and steering shaft should be eliminated before checking the steering gear adjustments.

1. Loosen the two bolts attaching the steering column bracket to the brake and clutch pedal support.
2. Loosen the steering column opening cover plate-to-dash panel bolts (5).
3. Loosen the steering column opening cover clamp bolt.
4. Verify the coupling pin to flange cut-out clearance of 4.06mm (0.160 inch) (Fig. 1).
5. If required, loosen and retighten the flange coupling nuts to 19-28 N·m (14-21 ft-lbs).
6. Tighten the steering column-to-support bracket bolts to 26-37 N·m (19-27 ft-lbs).
7. Tighten the steering column floor opening cover plate-to-dash panel bolts to 16-24 N·m (12-18 ft-lbs).
8. Tighten the steering column opening cover clamp bolt to 16-24 N·m (12-18 ft-lbs).

Automatic Transmission Selector Indicator (PRND21) (PRN⒟D1) and (PRN⒟21)

F-150—F-350 and Bronco

Functional Test

NOTE: Use the following procedure to determine if the Automatic transmission selector indicator or the shift control Linkage needs to be adjusted:

Position the selector lever in ⒟ (D for C6) and hold the lever downward against the internal steering column stop. If the indicator flag totally fills the rectangular adjustment window, then the selector indicator is adjusted correctly. The shift control linkage must now be adjusted as detailed in Section 17-02, Shift Control Linkage. If the indicator flag does not totally fill the rectangular adjustment window while the selector lever is held against the stop, then continue with the following adjustment.

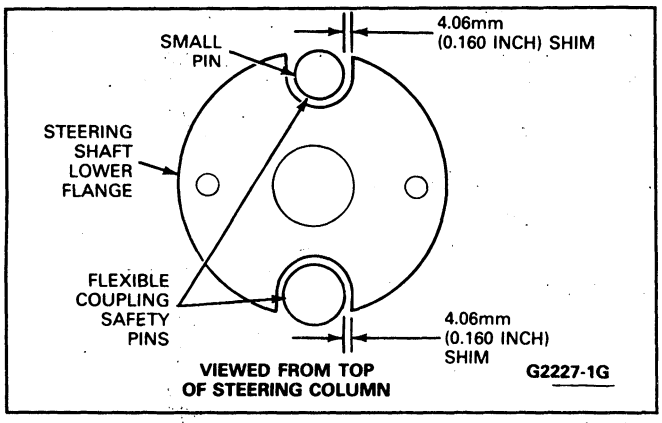


FIG. 1 Flexible Coupling Alignment E-150—E-350

Adjustment

Refer to Fig. 4.

Adjust the indicator flag alignment in the following steps:

NOTE: The shroud must be removed.

1. With the engine stopped and the parking brake applied, place the transmission selector lever at the steering column in the ⒟ position (D position for C6 transmission) and hold the lever against the stop by applying an 8 pound weight to the selector lever.

NOTE: This adjustment must be made in the ⒟ position only (D for C6).

2. Place the cable loop over the retainer pin on the shift socket casting (Fig. 6). Place the cable bracket in the "T" slot in the column outer tube.
3. Adjust cable bracket in slot until the indicator flag totally fills the rectangular adjustment under the ⒟ (D for C6).
4. Tighten bracket screw to 2.25 N·m (20 in-lb) without disturbing the flags position. Release lever.
5. In all "R", "N", "2", and "1" or "R", "N", "D" and "1", the indicator flag should totally fill the shift position letters or numerals.

NOTE: After the shift lever indicator flag has been adjusted the manual linkage must be checked as detailed in Section 17-02, Shift Control Linkage.

Ignition Switch Adjustment

The ignition switch is operated by a rod through the lock actuator rack and pinion driven by the key cylinder. Rotating the key clockwise from the full counter-clockwise stop, the positions are: ACCESSORY, LOCK, OFF, ON, and START.

If the switch is properly adjusted:

(a) In ACCESSORY, the accessory circuit is operative and the steering wheel is locked.

(b) In LOCK, all ignition switch electrical circuits are inoperative and the steering wheel is locked.

(c) In OFF, all ignition switch electrical circuits are inoperative and the steering wheel is unlocked for all gear shift lever positions.

(d) In ON (RUN), all ignition switch circuits (or "Accessory" Circuits) are operative except the starter circuit and warning lamp proof circuit and the steering wheel is unlocked.

(e) In START, the engine ignition, warning lamp proof circuit and starter circuits only are operative and the steering wheel is unlocked.

If the switch is out of adjustment see Section 33-71, Ignition Switch under Adjustments.

Steering Wheel Alignment For Spoke Position—Clear Vision

F-150—F-350, Bronco and F-Super Duty

Steering wheel clear vision (Figs. 2 and 3) is preset at vehicle assembly prior to toe-adjustment and cannot be

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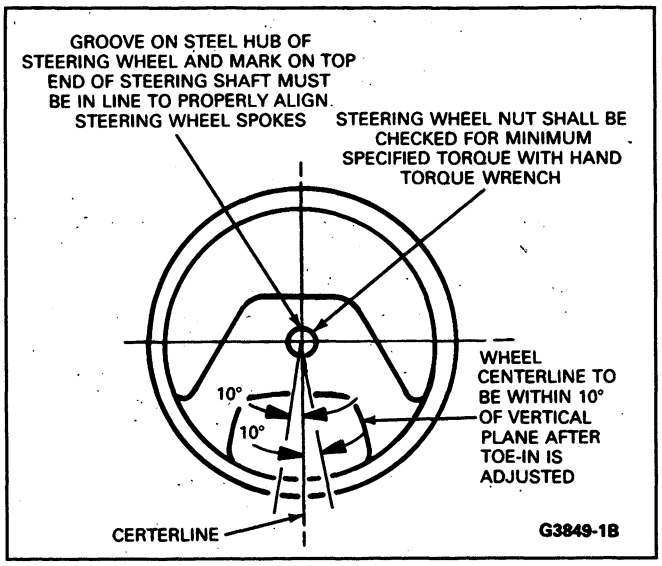


FIG. 2 Acceptable Steering Wheel Position—Measured From Normal Spoke Angle F-150—F-350, Bronco and F-Super Duty

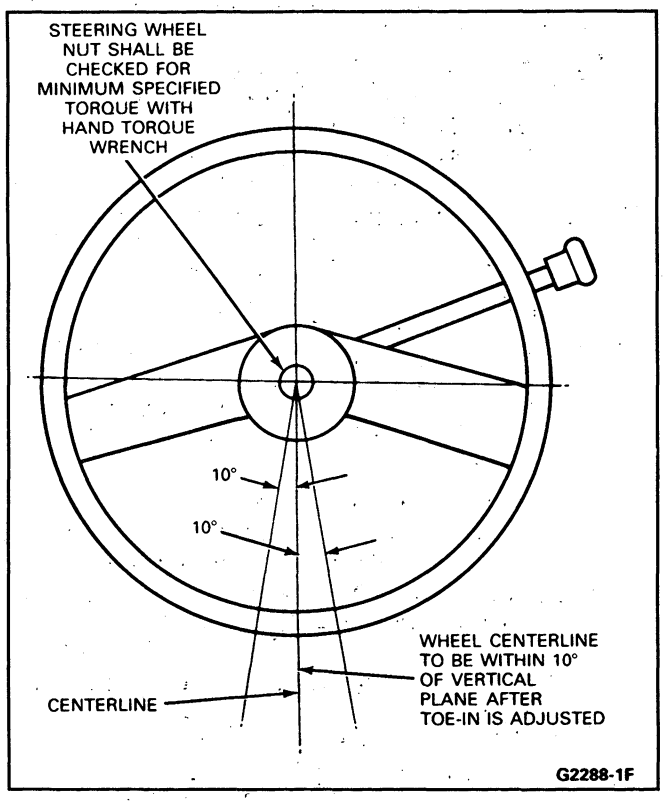


FIG. 3 Acceptable Steering Wheel Installation—Measured From Normal Spoke Angle E-150—E-350

adjusted by removing the steering wheel and reindexing the steering wheel and steering shaft. Mating flats on the wheel hub and steering shaft assure that misindexing of these components is prevented. The alignment of the notches on the steering wheel hub and steering shaft confirm correct orientation.

Positive indexing of intermediate shaft pot joint to steering shaft and flex coupling to intermediate shaft are additional features to assure correct assembly. These are noted as follows: Refer to Fig. 5.

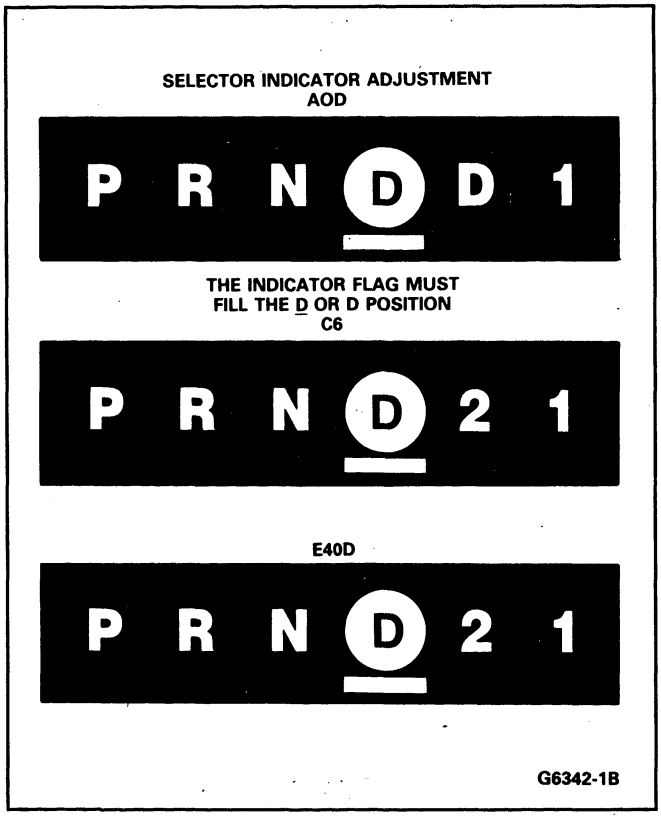


FIG. 4 Selector Indicator Adjustment

- Pot joint alignment notch is at 12 o'clock when steering wheel is in straight ahead position (refer to Fig. 5).

Resolve the clear vision complaint by re-adjusting toe as described in Section 14-01, General Suspension Service.

E-150—E-350

Steering wheel clear vision (Figs 2 and 3) is preset at vehicle assembly prior to toe-adjustment and cannot be adjusted by removing the steering wheel and reindexing the steering wheel and steering shaft. Mating flats on the wheel hub and steering shaft assure that misindexing of these components is prevented. The alignment of the notches on the steering wheel hub and steering shaft confirm correct orientation.

Positive indexing of the flex coupling to the steering gear and steering column flange are additional features to assure correct assembly. The small pin on the flex coupling is at 12 o'clock when steering wheel is in the straight ahead position (Fig. 1).

Resolve any clear vision complaint by re-adjusting toe as described in Section 14-01, General Suspension Service.

REMOVAL AND INSTALLATION

Steering Wheel

E-150—E-350

Removal

1. Disconnect the battery ground cable.
2. Remove one screw from the underside of each steering wheel spoke, and lift the horn switch

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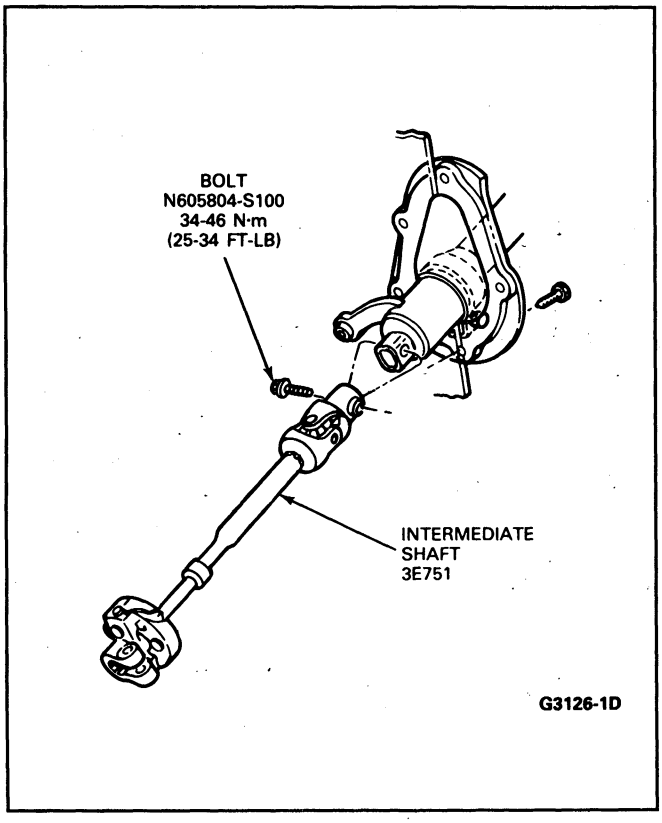


FIG. 5 Pot Joint Alignment F-150—F-350, Bronco and F-Super Duty

assembly (steering wheel pad) from the steering wheel.

3. Disconnect the horn switch wires by pulling the spade terminal from the blade connectors. On vehicles equipped with speed control, squeeze or pinch the "J" clip ground wire terminal firmly and pull it out of the hole in the steering wheel. Do not pull the ground terminal out of the threaded hole without squeezing the terminal clip to relieve the spring retention of the terminal in the threaded hole.
4. Remove the horn switch assembly.
5. Remove steering wheel retaining nut.
6. Use the Steering Wheel Puller, T67L-3600-A or equivalent and remove steering wheel from shaft. Do not hammer on the steering wheel or center shaft or use a knock-off type steering wheel puller as either procedure will damage the steering column.

Installation

Place the steering wheel on the steering column upper shaft, so that the mark and flat on the steering wheel is in line with the mark and flat on the steering column center shaft.

1. Install a steering wheel lock nut (382412-S2 or equivalent). Tighten the nut to 41-57 N·m (30-42 ft-lb).
2. Connect the horn and speed control wires (if equipped).
3. Install the steering wheel horn cover pad. Tighten the screws to 0.8-1.2 N·m (7-11 in-lbs).
4. Connect the negative (-) battery cable to the terminal.
5. Test the steering column for proper operation.

Steering Intermediate Shaft and Flex Coupling

F-150—F-350, Bronco

Removal

Refer to Fig. 6.

1. Remove bolt and nut connecting intermediate shaft to steering column.
2. Remove the cover from the flexible coupling.
3. Remove the pinch bolts and disengage the lower end of the intermediate shaft from the steering gear.

Installation

1. Install the intermediate shaft to steering gear and tighten the pinch bolt to 34-46 N·m (25-34 ft-lbs).
2. Install the cover over the intermediate shaft and attach to steering gear.
3. Attach intermediate shaft to steering column, making sure notch in pot joint is matched to the flat on the column shaft (Fig. 4). Install nut and bolt and tighten to 46-68 N·m (35-50 ft-lbs).

Steering Column

F-150—F-350, Bronco and F-Super Duty

Refer to Fig. 6.

Removal

Set parking brake before proceeding. Also remove the battery cable from the negative terminal.

1. Remove bolt and nut attaching intermediate shaft to steering column.
2. Disconnect shift linkage rod(s) from column.
3. Remove steering wheel as outlined in this section. If a tilt steering column is being serviced, the steering wheel must be in the full "UP" position when it is removed, be sure the full "UP" position is attained.
4. Remove the steering column floor opening cover plate screws.
5. Remove shroud by loosening screw at bottom, selecting position "1" on automatics and spreading shroud open. Pull shroud out of instrument panel opening, while pulling up and away from column.
6. Remove PRND21 indication actuation cable (automatics).
7. Remove the instrument panel column opening cover.
8. Remove the bolts attaching the column support bracket to the pedal support bracket.
9. Disconnect the turn signal-hazard warning and ignition switch wiring harnesses.
10. Remove column from vehicle.
11. Remove column support bracket from steering column.

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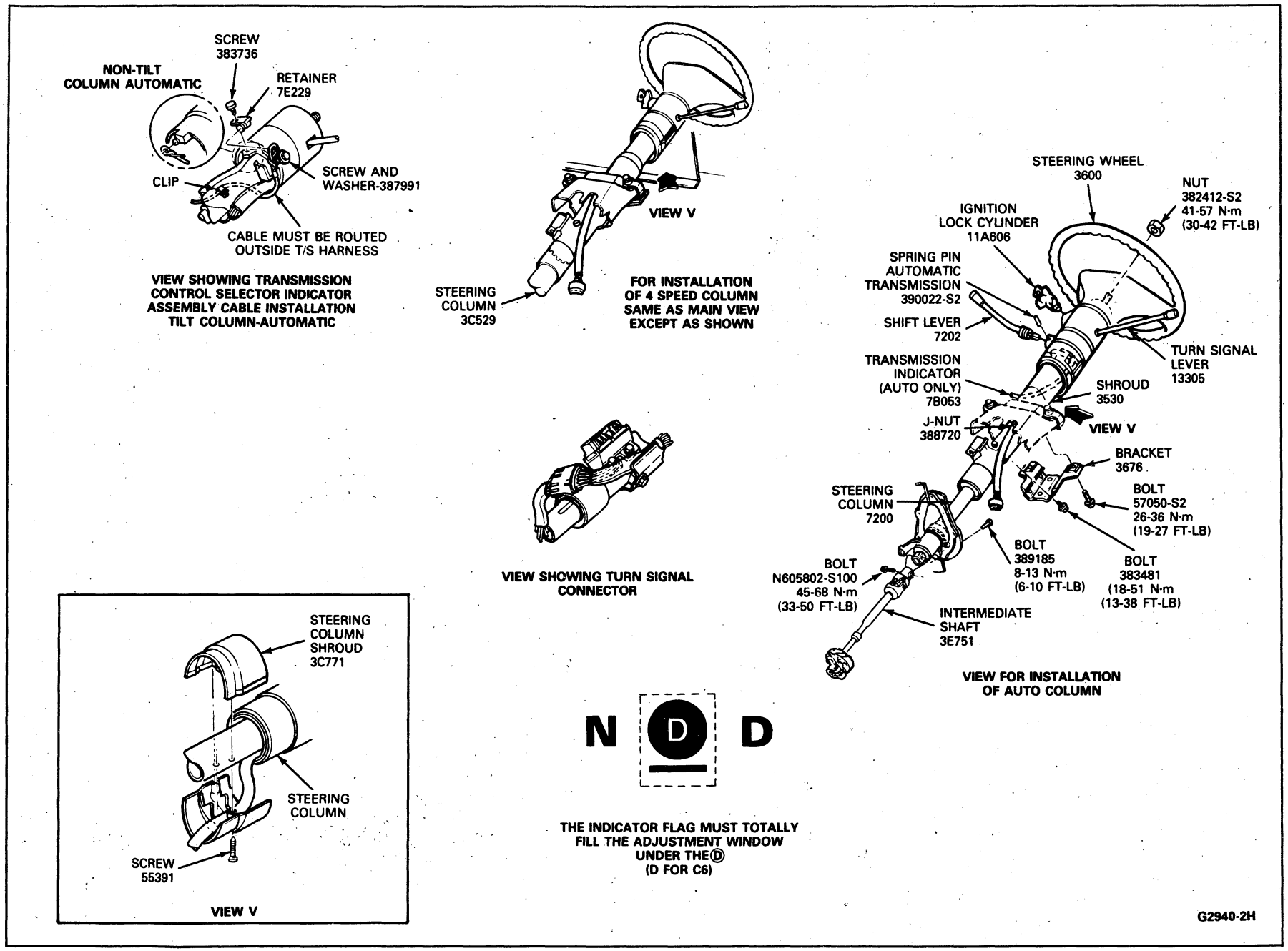


FIG. 6 Steering Column Installation—F-150—F-350, Bronco and F-Super Duty

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Installation

1. Attach steering column support bracket making sure turn signal-hazard warning wiring is on outboard side of column. Tighten nuts to 18-51 N·m (13-38 ft-lbs).
2. Start the floor opening cover clamp bolt and press the plate until clamp flats touch the stops on column outer tube.
3. Load column into vehicle through opening in floor.
4. Connect turn signal-hazard warning and ignition switch wiring harnesses.
5. Raise column up to pedal support bracket and hand start the 2 bolts.
6. Fasten floor opening cover plate to floor. Tighten to 8-14 N·m (6-10 ft-lbs).
7. Tighten the 2 support bracket bolts 26-37 N·m (19-27 ft-lbs).
8. Tighten the cover plate clamp bolt 11-24 N·m (8-18 ft-lbs).
9. Install and adjust the PRND21 indication actuation cable on automatics as described in this Section.
10. Install instrument panel steering column opening cover.
11. Mount shroud by selecting position "1" on automatic transmissions, spreading shroud around steering column and through opening in instrument panel. Post on interior will index shroud when properly positioned.
12. Tighten screw at bottom of shroud 1.1-1.7 N·m (10-15 in-lbs).
13. Attach shift linkage rod(s) to column.
14. Fasten intermediate shaft to steering column. Tighten to 46-68 N·m (35-50 ft-lbs).

Steering Column

E-150—E-350

Refer to Fig. 7.

Removal

1. Set the parking brake.
2. Remove the battery cable from the negative (-) post.
3. Remove the 2 nuts attaching the flexible coupling to the steering shaft flange (Fig. 7).
4. Remove the shift linkage rod(s) from the steering column.

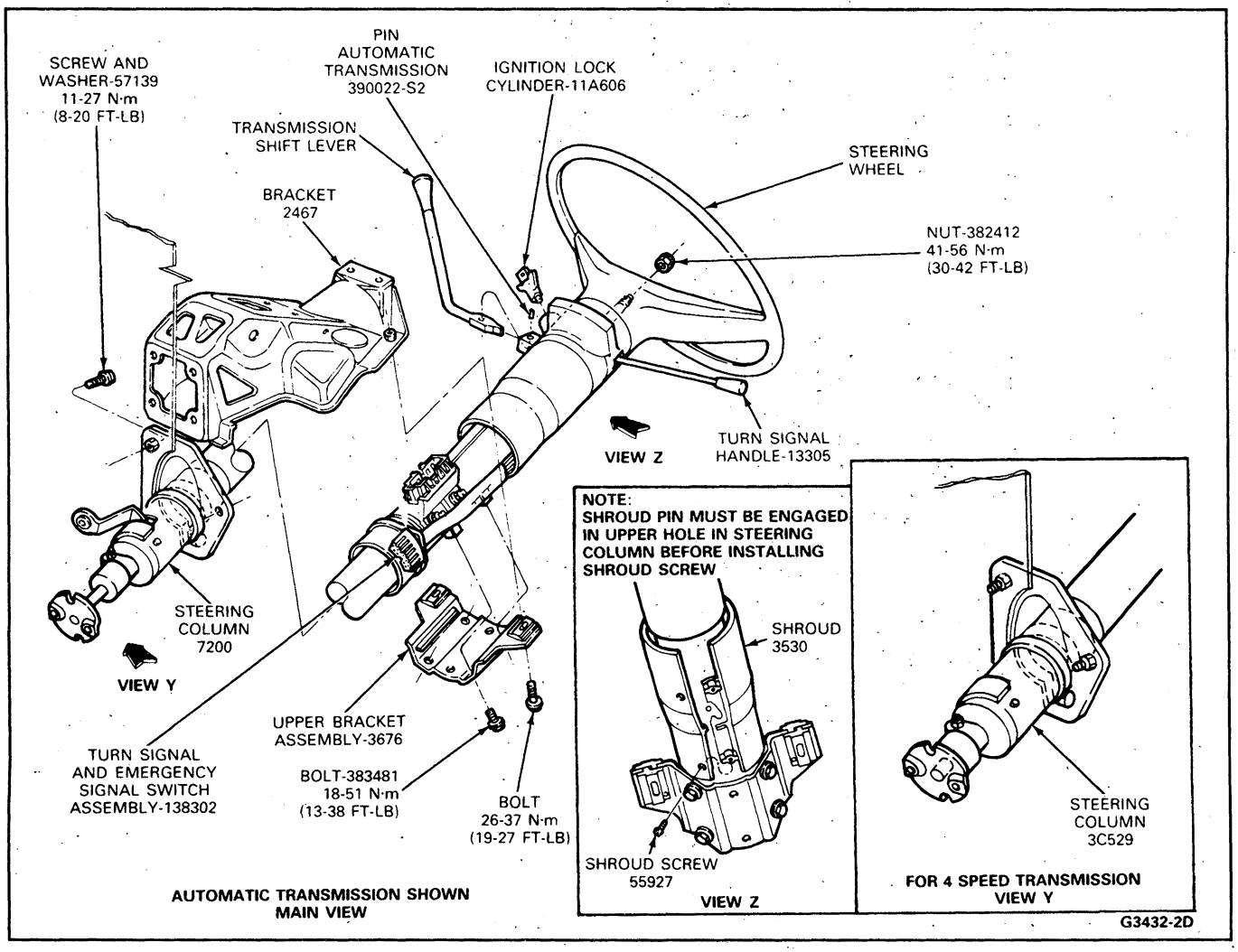


FIG. 7 Steering Column Installation—E-150—E-350

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5. Remove the steering wheel as described in this Section. If a tilt steering column is to be serviced, the steering wheel must be in the full "UP" position when it is removed. Be sure the full "UP" position is attained.
6. Remove the steering column floor opening cover plate screws.
7. Remove the shroud by loosening the screw at the bottom. Place the shift lever in "1" on automatic transmission models. Spread the shroud and withdraw it from the instrument panel opening while pulling up and away from the column.
8. Remove the instrument cluster column opening cover.
9. Remove the 2 bolts attaching the column bracket to the pedal support bracket.
10. Disconnect the turn signal-hazard warning and ignition switch wiring harnesses.
11. Remove the steering column from the vehicle.
12. Remove the steering column support bracket from the column.

Installation

1. Place the steering column in the vehicle.
2. Connect the turn signal-hazard warning and ignition switch wiring harnesses.
3. Inserting the steering shaft flange through the floor opening such that the flange engages the flexible coupling, raise the steering column up to the pedal support bracket. Loosely install the column support bolts.
4. When the column has been removed, the flange assembly will be fully telescoped into the column. Gently tap the flange down to engage the flexible coupling.
5. Loosely install the flexible coupling flange nuts and floor plate fasteners.
6. Align the steering column and flexible coupling as described in Steering Column Alignment and Adjustments in this Section (Steps 4-8). Install the steering wheel and align as described in this Section.
7. Attach the shift linkage rod(s).
8. Connect the battery.

Upper Components—Steering Column: Upper Shaft Bearing, Flange, and Shift Socket/ Flange Extension

To facilitate service of upper steering column components, steering column removal and disassembly is recommended. Refer to Disassembly and Assembly—Steering Column in this Section.

Lower Bearing Retainer

F-150—F-350, Bronco and F-Super Duty

Refer to Fig. 18.

The bearing retainer may be removed and disassembled without disassembling the rest of the column.

NOTE: For E-150—E-350 columns must be removed. See Disassembly and Assembly in this Section.

Removal—From The Vehicle Without Column Removal

1. Disconnect steering coupling shaft from steering column.
2. Remove the 3 bearing retainer screws.
3. Remove the bearing retainer assembly.

Installation—While Column Is In Vehicle

1. Install the bearing retainer assembly on steering shaft aligning flats on shaft with flats on shaft retainer.
2. Slide bearing retainer onto shaft and into position, being careful not to compress telescoping steering shaft.
3. Fasten the bearing retainer assembly to column outer tube 1.4-2.3 N·m (12-20 in-lbs).
4. Centerline of coupling shaft attachment hole must extend 20.3mm (0.8 inches) below bearing retainer lower face. Minor adjustments may be made by gentle tapping in the appropriate direction on the shaft.
5. Attach the coupling shaft and tighten to 61-80 N·m (45-59 ft-lbs).

Floor Opening Cover Plate

Removal

1. Remove the steering column from the vehicle as described in this Section.
2. Remove the lower bearing retainer as described in the preceding procedure.
3. Drill out the shift tube retention rivet on automatic transmissions (Fig. 20).
4. Drive out the shift lever pivot pin and remove the shift lever on automatic transmission vehicles.
5. Partially withdraw the shift tube assembly on automatic transmissions.
6. Remove the cover plate clamp and remove cover plate.

Installation

1. Install cover plate on steering column outer tube so that the dished surface is facing up the column. Reinstall clamp ensuring clamp engages cover plate tabs.
2. Hand start the clamp bolt.
3. Reverse the removal procedure. Install a new 3/16 inch pop rivet (Fig. 20).

Column Lock Actuator and Steering Wheel Lock Pin

Removal

1. Remove the steering column from the vehicle as described in this Section.
2. Disassemble the column as described in this Section to remove the flange.
3. Remove the ignition lock drive gear described in this Section.
4. Withdraw the steering wheel lock pin—ignition switch actuator assembly.
5. Remove and discard the retaining clip at the lower end of the lock pin. Remove the pin and spring

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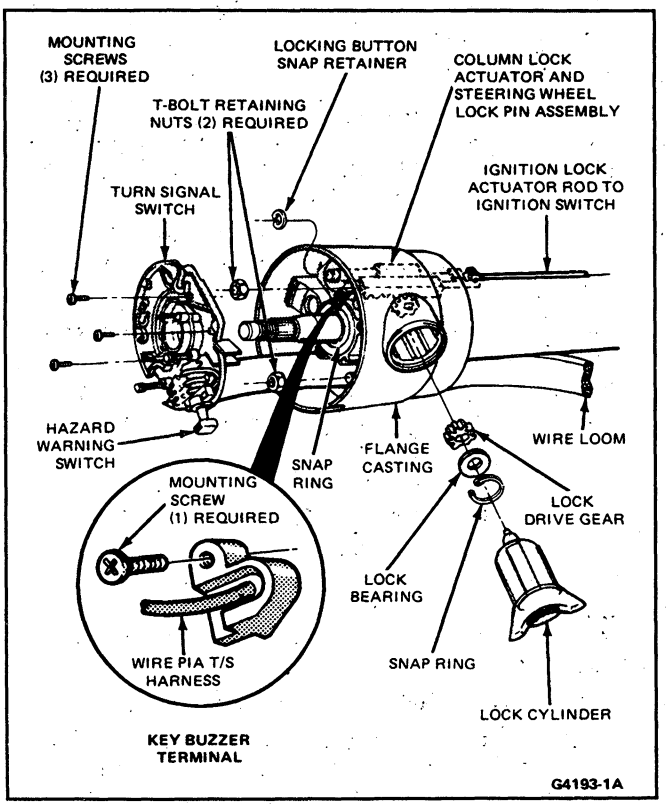


FIG. 8 Non-Tilting Column Mechanism

from the ignition switch actuator. **Do not lose the spring.**

Installation

1. Install a new lock pin and clip, and the old lock pin spring in the actuator.
2. Place the steering wheel lock pin-ignition switch actuator assembly in the flange casting.
3. Install the lock drive gear as described in this Section.
4. Assemble the column as described in this Section.
5. Install the steering column as described in this Section.

Ignition Lock Cylinder Assembly (With Key)

Refer to Fig. 8.

Removal

1. Disconnect the battery ground cable.
2. Remove the steering wheel trim pad and the steering wheel as described earlier in this Section for Non-Tilt Steering Columns only.
3. Place the gear shift in PARK (with automatic transmission) and turn the lock cylinder with the ignition key to ON position.
4. Place 3.17mm (1/8 inch) diameter wire pin or small drift punch and depress the retaining pin while pulling out on the lock cylinder to remove it from the column housing. The pin is located inside the column near the base of the lock cylinder on Non-Tilt Steering Column (Fig. 9). On Tilt-Steering Columns the pin is located adjacent to the Hazard Warning Button (Fig. 10).

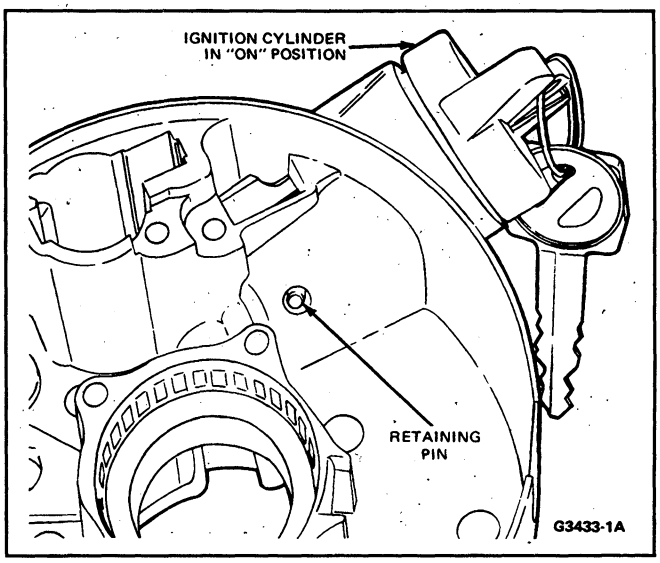


FIG. 9 Lock Retaining Pin Access Slot—Non-Tilt Column

Installation

1. Lubricate the lock cylinder with grease.
2. To install the lock cylinder, turn the lock cylinder to the ON position and depress the retaining pin, then insert the lock cylinder into its housing in the flange casting. Assure that the cylinder is fully seated and aligned into the interlocking washer before turning the key to the OFF position. This action will permit the cylinder retaining pin to extend into the cylinder casting housing hole.
3. Using the ignition key, rotate the lock cylinder to insure correct mechanical operation in all positions.
4. Install the steering wheel and trim pads as described earlier in this Section on Non-Tilt Steering Columns only.
5. Connect the battery ground cable.
6. Check for proper start in Park or Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.

Ignition Lock Cylinder (Without Key)

NOTE: The following procedure applies to vehicles where the ignition lock is inoperative and the lock cylinder cannot be rotated due to a lost or broken ignition key and the key number not known or the lock cylinder cap is damaged and/or broken to the extent that the lock cylinder cannot be rotated.

Removal (Non-Tilting Column)

1. Disconnect the battery ground cable.
2. Remove the steering wheel and pad assembly as described earlier in this Section.
3. Remove the turn signal lever from the steering column.
4. To gain access to the ignition switch remove the steering column trim shrouds from the steering column. Detach and lower the steering column assembly from the brake pedal support bracket as described earlier in this Section.

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5. Remove the ignition switch and key warning buzzer terminal and pin it in the LOCK position as described in this Section under Adjustments.
6. Remove the turn signal switch from the column assembly as described in this Section.
7. Remove the upper bearing snap ring and the (2) T-bolt retaining nuts that secure the flange casting to the outer tube. Remove the entire flange casting assembly, the upper shaft bearing, the lock cylinder assembly, the ignition switch actuator and the ignition switch actuator rod by pulling the assembly over the end of the steering column shaft (Fig. 11).
8. Remove the lock actuator insert, the T-bolts, and the PRND21 insert on automatic transmissions or the key release lever assembly on manual transmissions.
9. Replace the above assembly with a new assembly consisting of:

   (1) 3511 Flange

   (1) 11582 Lock Cylinder Assembly

   (1) 3E717 Lock Gear, Steering Column Lock

   (1) 3E700 Bearing, Steering Column Lock

   (1) 3C610 Retainer, Steering Column Upper Bearing

   (1) 3E723 Actuator Assembly, Steering Column Lock
10. Install the key release lever assembly on 4-speed equipped vehicles and the PRND21 insert on vehicles with automatic transmission. Install the T-bolts and lock actuator insert.

NOTE: Retain the ignition switch actuating rod from the removed casting assembly and use it with the new flange casting assembly.

Installation (Non-Tilting Column)

1. Reassemble the above parts, install a new upper shaft bearing (3517) and set the actuator to drive gear as described earlier in this Section.
2. Install the turn signal—hazard warning switch and key warning buzzer as described earlier in this Section.
3. Install the ignition switch, check and/or adjust for proper function as specified in Section.
4. Install the steering column assembly to the brake pedal support bracket as specified earlier in this Section.
5. Install the steering column trim shrouds, steering wheel and pad assembly as specified earlier in this Section.
6. Install the turn signal lever.
7. Using the ignition key, rotate the lock cylinder to insure correct mechanical operation in all positions.
8. Connect the battery ground cable.
9. Check for proper start in Park and Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.

Removal (Tilting Column)

1. Disconnect the battery ground cable. Remove the steering column trim shrouds as described earlier in this Section.
2. Tape the gap between the steering wheel hub and the cover casting. Cover the entire circumference

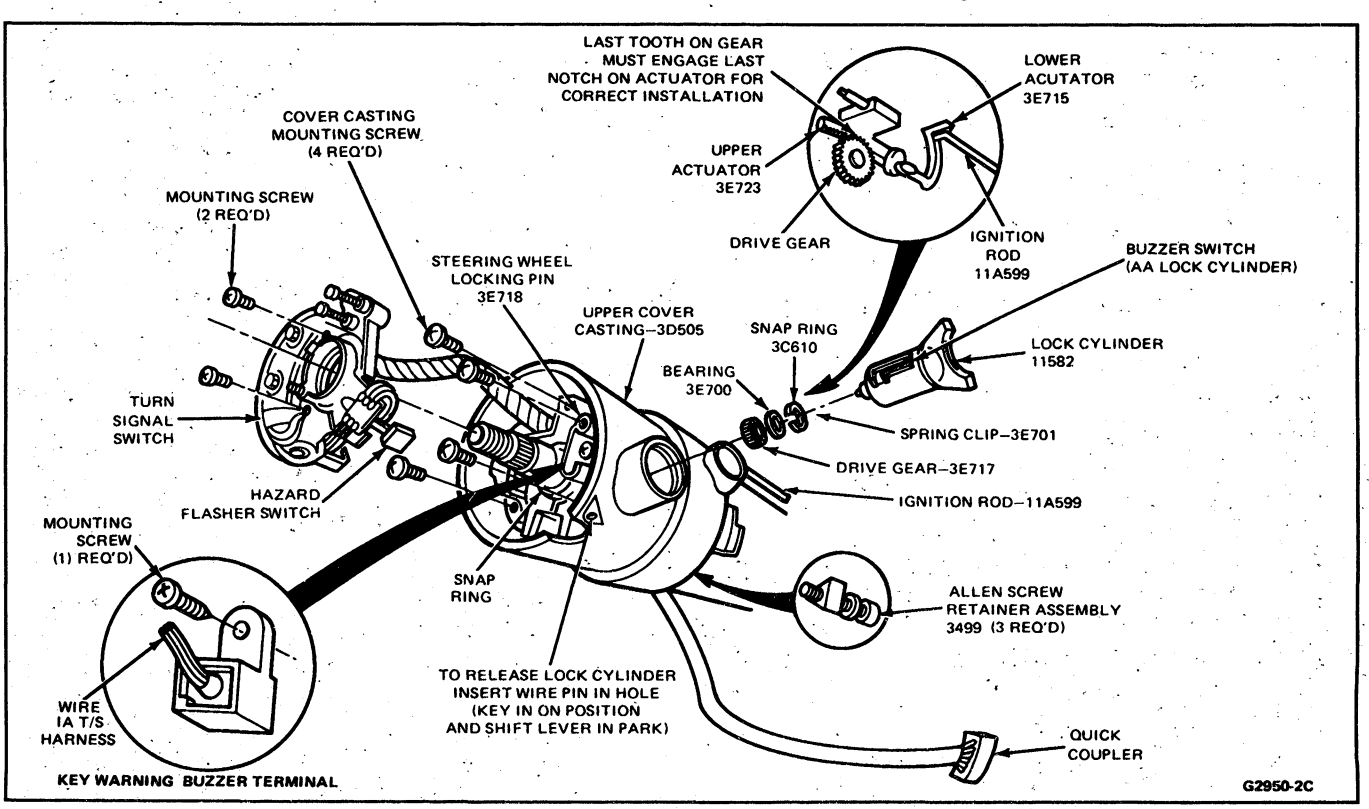


FIG. 10 Tilt Column Mechanism

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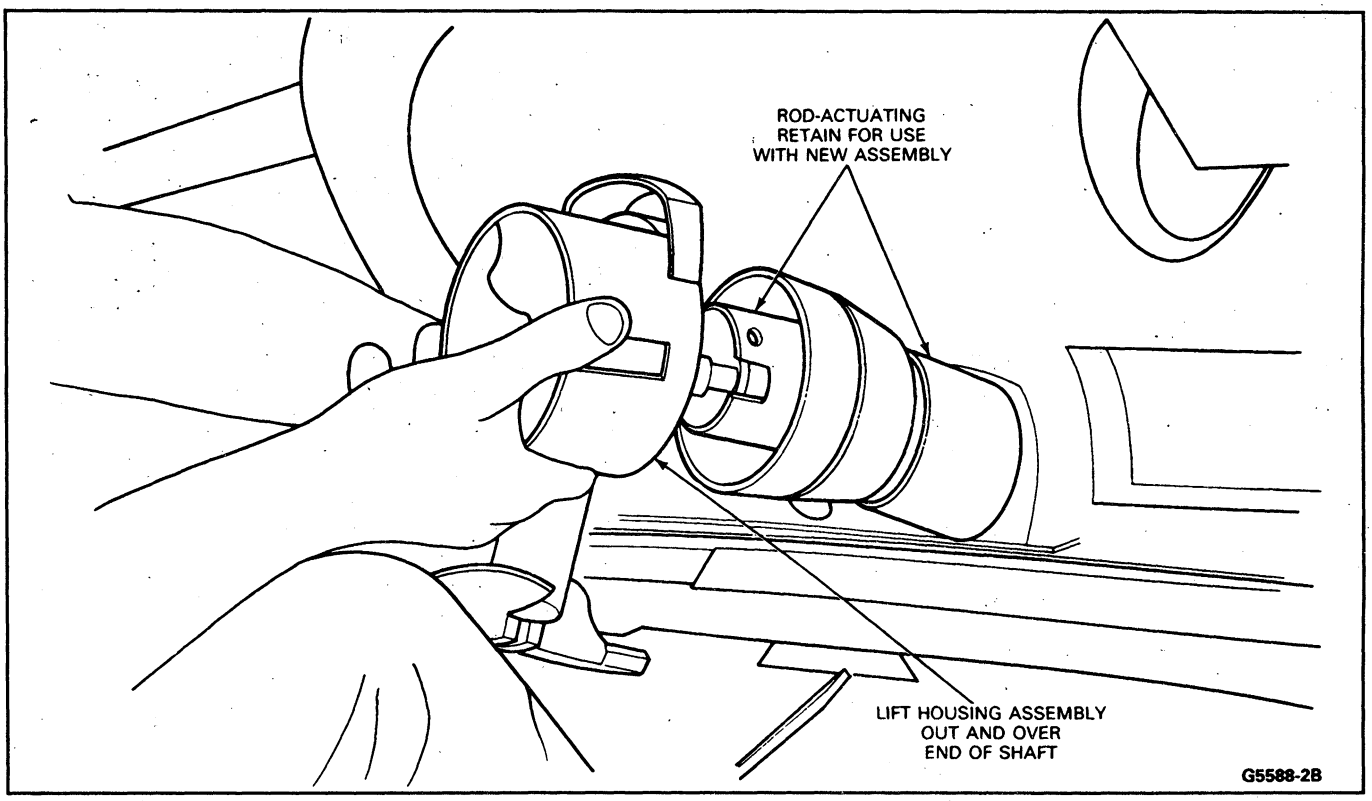


FIG. 11 Removing Flange Casting

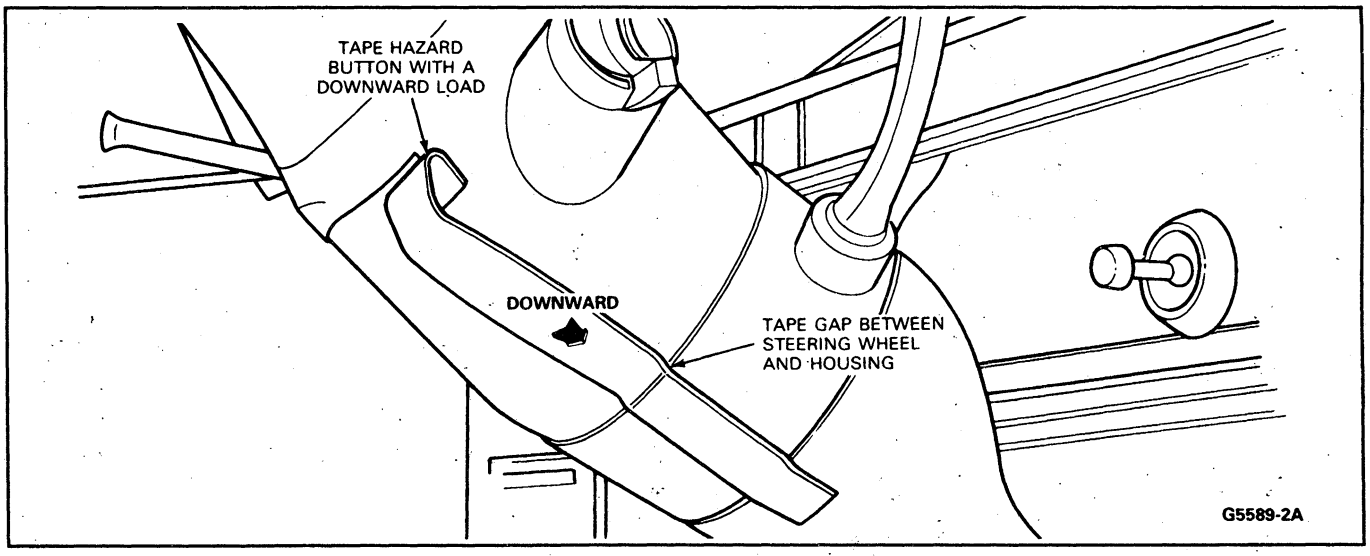


FIG. 12 Taping Hazard Switch

of the casting. Also cover the adjacent seat and floor area with a suitable covering to protect the surrounding interior upholstery. Pull out the hazard flasher switch and tape it down toward the floor as shown in Fig. 12 to provide clearance for drilling out the lock cylinder retainer pin.

3. The tilt column lock cylinder retaining pin is located on the outside of the steering column cover casting adjacent to the hazard flasher button.

4. Tilt the steering column to the full up position and prepunch the lock cylinder retaining pin with a prick punch. Using a 3.17mm (1/8 inch) diameter drill with a right angle drive, drill out the retaining pin, going no deeper than 12.7mm (1/2 inch). (Fig. 13).

   NOTE: When drilling out the retaining pin, take care not to damage the cover cast housing or the hazard flasher switch.

5. Tilt the steering column to the full down position. Place a chisel at the base of the ignition lock cylinder cap, and, using a hammer, strike the chisel with sharp blows to break the cap away from the lock cylinder. (Fig. 14).

6. Using a 9.8mm (3/8 inch) diameter drill, drill down the middle of the ignition lock key slot approximately 45mm (1-3/4 inch) until the lock

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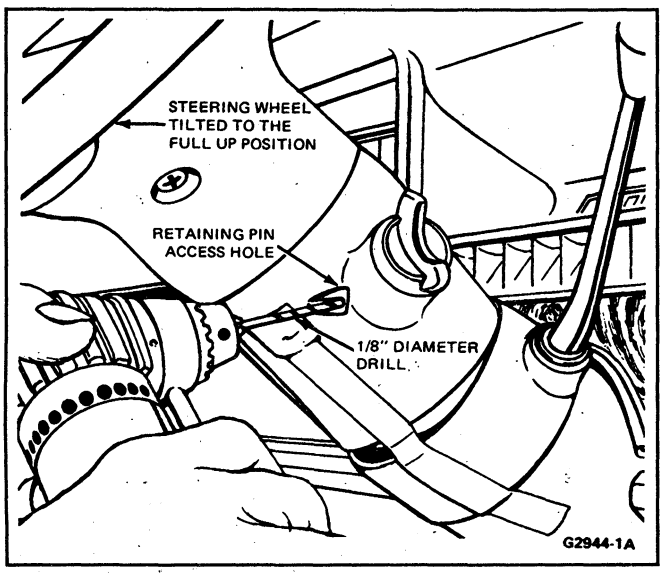


FIG. 13 Drilling Out The Lock Retaining Pin

cylinder breaks loose from the steering column cover casting. Remove the lock cylinder, and the drill shavings from the base of the cover cast housing (Fig. 15).

7. Remove the steering wheel and pad as described earlier in this Section.
8. Remove the turn signal lever from the column and then remove the two attaching screws from the turn signal switch and one attaching screw from the key warning buzzer terminal. Lift the turn signal switch up and over the end of the steering shaft but do not disconnect it from the wiring harness.
9. Remove the four attaching screws from the cover casting and lift the casting over the end of the steering shaft allowing the turn signal switch to pass through the cover casting. The removal of the cover casting will expose the upper actuator (3E723). Remove the upper actuator.
10. Remove the drive gear, snap ring and washer from the cover casting along with the upper actuator mentioned above. Thoroughly clean the components in an acceptable cleaning solution. Carefully inspect all components for any damage resulting from the drilling operation. If any of the components show signs of damage, they must be replaced. Clean the removed cover casting with compressed air to remove any drill shavings or foreign particles and carefully inspect it for damage. If the cover casting is damaged, replace it with a new one primed and painted to match the existing column.

Installation (Tilting Column)

1. Lubricate the tang of the lock cylinder with grease.
2. Attach the upper actuator to the lower actuator and lubricate the upper actuator. Reassemble the cover casting, upper actuator, turn signal switch and lever, lock drive gear, lock cylinder, steering wheel and pad, and the steering column trim shrouds as described earlier in this Section.
3. Using the ignition key, rotate the lock cylinder to insure correct mechanical operation in all positions.
4. Connect the battery ground cable.

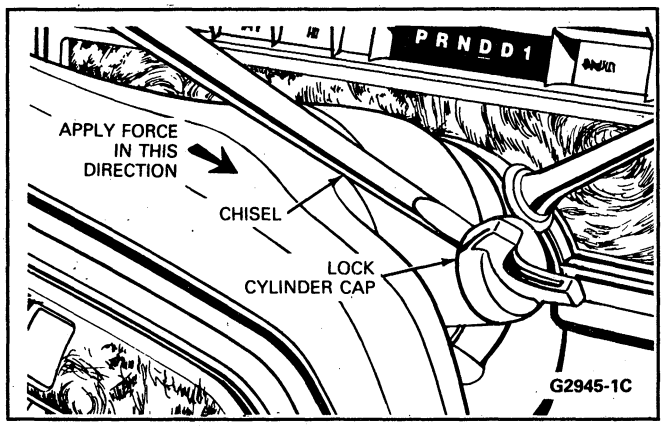


FIG. 14 Breaking The Cap Away From The Lock Cylinder

5. Check for proper start in Park or Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.

Ignition Lock Drive Gear

Refer to Figs. 8 and 10.

Removal

1. Remove the lock cylinder assembly as detailed in this Section.
2. Insert a flat-bladed screwdriver in the recess of the drive gear at the bottom of the lock cylinder housing. Turn the lock drive gear counterclockwise three notches.
3. Remove the snap ring, washer and lock drive gear from the lock cylinder housing. Note the position of the drive gear to the rack teeth.

Installation

1. Install the lock drive gear in the housing in the same position as noted during removal. Installation is correct if the last tooth on the drive gear is meshed with the last tooth on the rack. Install the washer and snap ring.
2. Using the screwdriver blade, turn the drive gear clockwise three notches.
3. Install the lock cylinder.

Manual Transmission Key Release Button and Lever

Refer to Fig. 16.

NOTE: All manual transmission equipped vehicles require the column to be removed from the vehicle to service these components.

Removal

1. Remove the steering wheel as described in this Section.
2. Remove the shroud.
3. Remove the 3 screws retaining the flange extension. Allow the extension to slide down the column. (Manual 4-speed only).
4. Remove the turn signal lever (non-tilt only).
5. Remove the turn signal-hazard warning switch and key warning buzzer terminal retaining screws. Withdraw the switch from the flange, over the steering shaft, and allow it to hang (non-tilt only).

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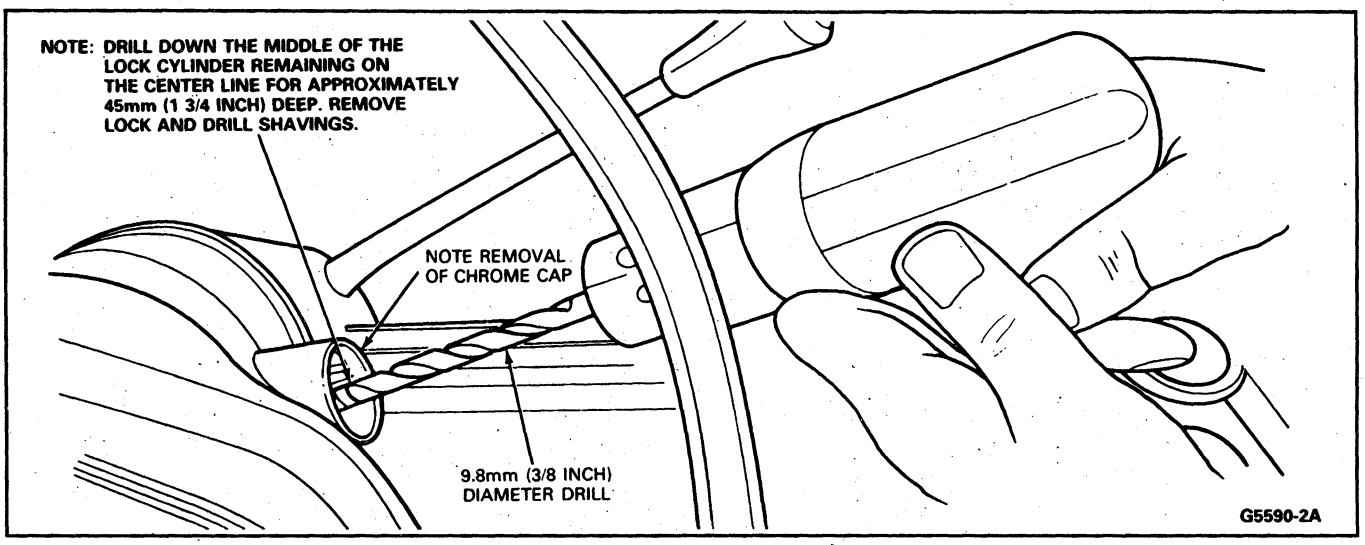


FIG. 15 Drilling Out the Cylinder

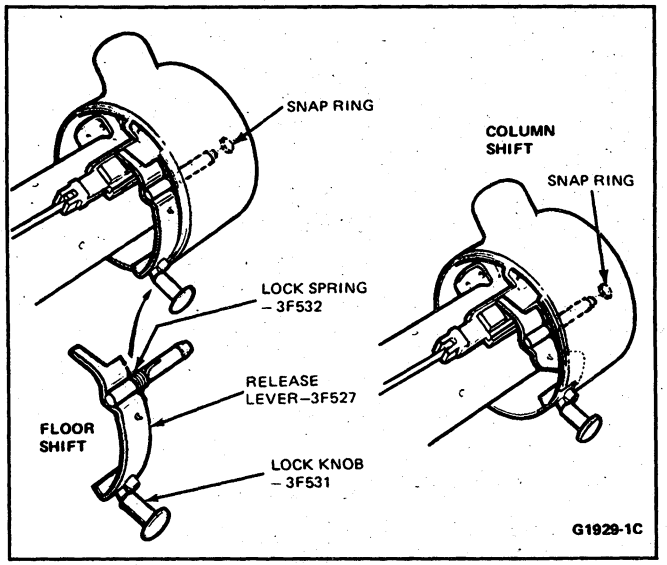


FIG. 16 Locking Button Installation for Non-Tilt Columns

6. Remove and discard the snap ring from the release lever pivot pin.
7. Remove the release lever and spring from the flange casting.
8. Remove the spring from the release lever.

Installation

1. Install the spring to the release lever.
2. Install the lever and spring on to the flange making certain that the spring is against the flange providing the automatic return of the lever.
3. Install a new snap ring.
4. Install the flange as described in this Section.
5. Install the turn signal-hazard warning switch and key warning buzzer terminal (non-tilt) tighten screws to 1.7-2.8 N·m (15-25 in-lbs).
6. Install the flange extension. Tighten screws to 1.1-2.2 N·m (10-20 in-lbs) (tilt) extension 1.7-2.5 N·m (15-22 in-lb).
7. Install the turn signal lever. Tighten to 3.4-5.1 N·m (30-45 in-lbs).
8. Install the steering wheel as described in this Section.

DISASSEMBLY AND ASSEMBLY

Non-Tilting Steering Column

Refer to Figs. 17, 18 and 19.

Disassembly

1. Remove column from vehicle as described in this Section and clamp in vise.

   CAUTION: Clamping is permitted only on the upper tube. Care is to be taken not to permanently deform the tube wall. Permanent deformation may affect column performance during an accident.
2. Remove turn signal lever.
3. Drive out pivot pin and remove hand shift lever (automatics).
4. Partially withdraw turn signal-hazard warning switch and key warning buzzer terminal from upper flange.
5. Remove snap ring from upper steering shaft.
6. Remove lower bearing retainer from the bottom of the steering column.
7. Using a light hammer, gently drive the steering shaft out the bottom of the steering column.

   NOTE: Because the steering shaft is a two-piece telescoping type, harsh impacts at either end may alter the shaft in overall length, thus affecting assembly.
8. Using a #10 drill bit, drill out shift tube retaining rivet from bottom of shift socket on vehicles equipped with automatic transmissions (Fig. 20).
9. Withdraw shift tube assembly from column bottom on vehicles equipped with automatics.
10. With the ignition switch clipped in the lock position, remove ignition switch and actuator rod.
11. Remove the PRND21 hood and lens assembly on E-150—E-250—E-350 automatics only.

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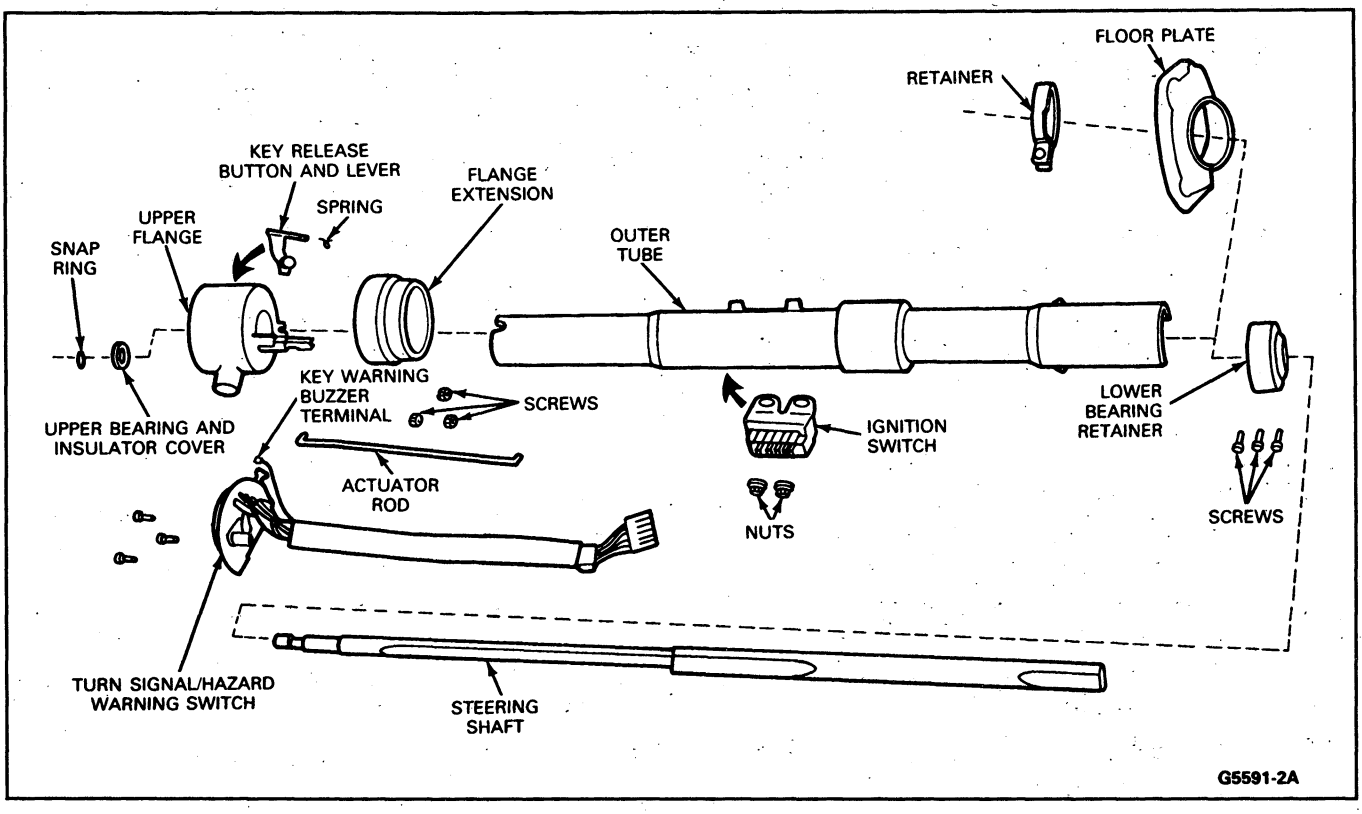


FIG. 17 4-Speed Manual Transmission Non-Tilting Steering Column Exploded View—F-150—F-350, Bronco and F-Super Duty

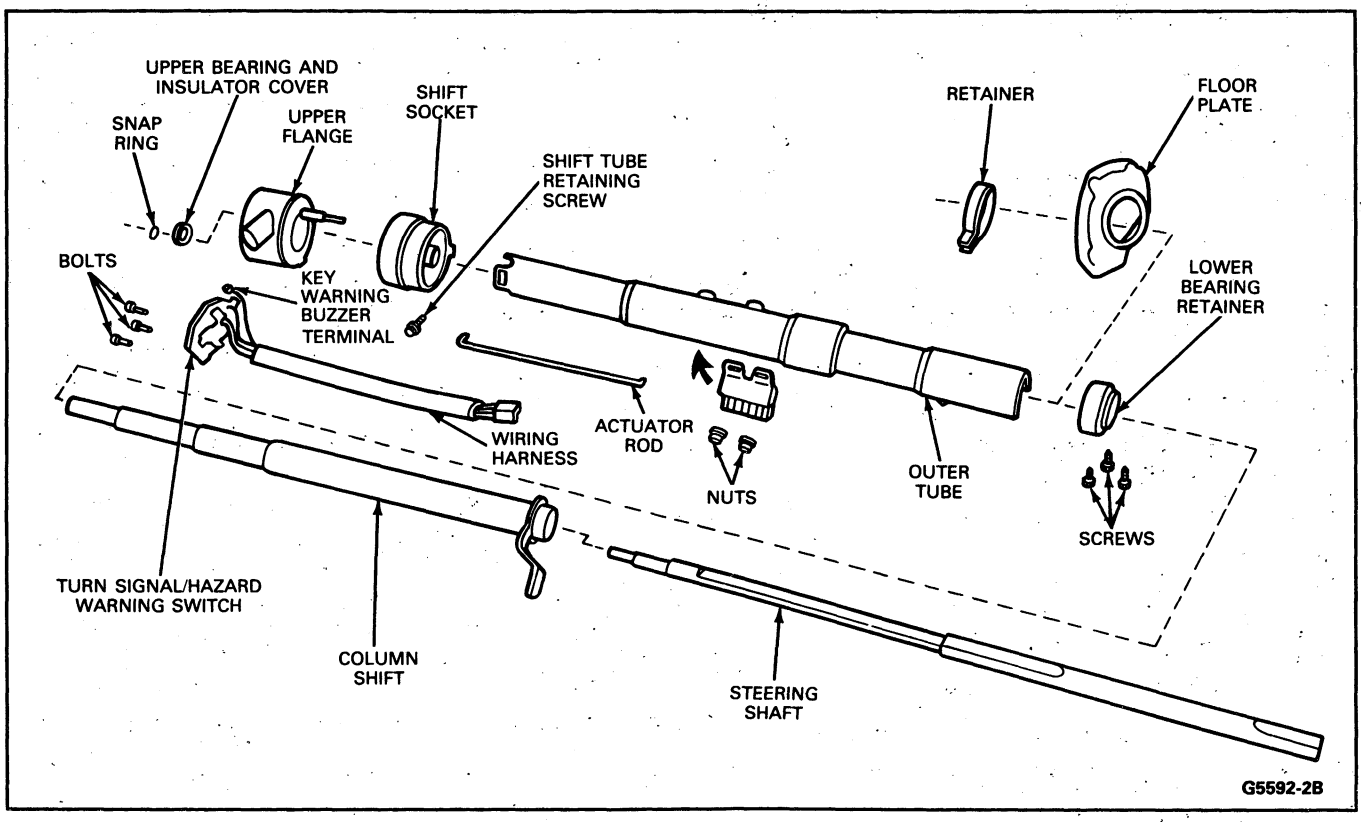


FIG. 18 Automatic Transmission Non-Tilting Steering Column Exploded View—F-150—F-350, Bronco and F-Super Duty

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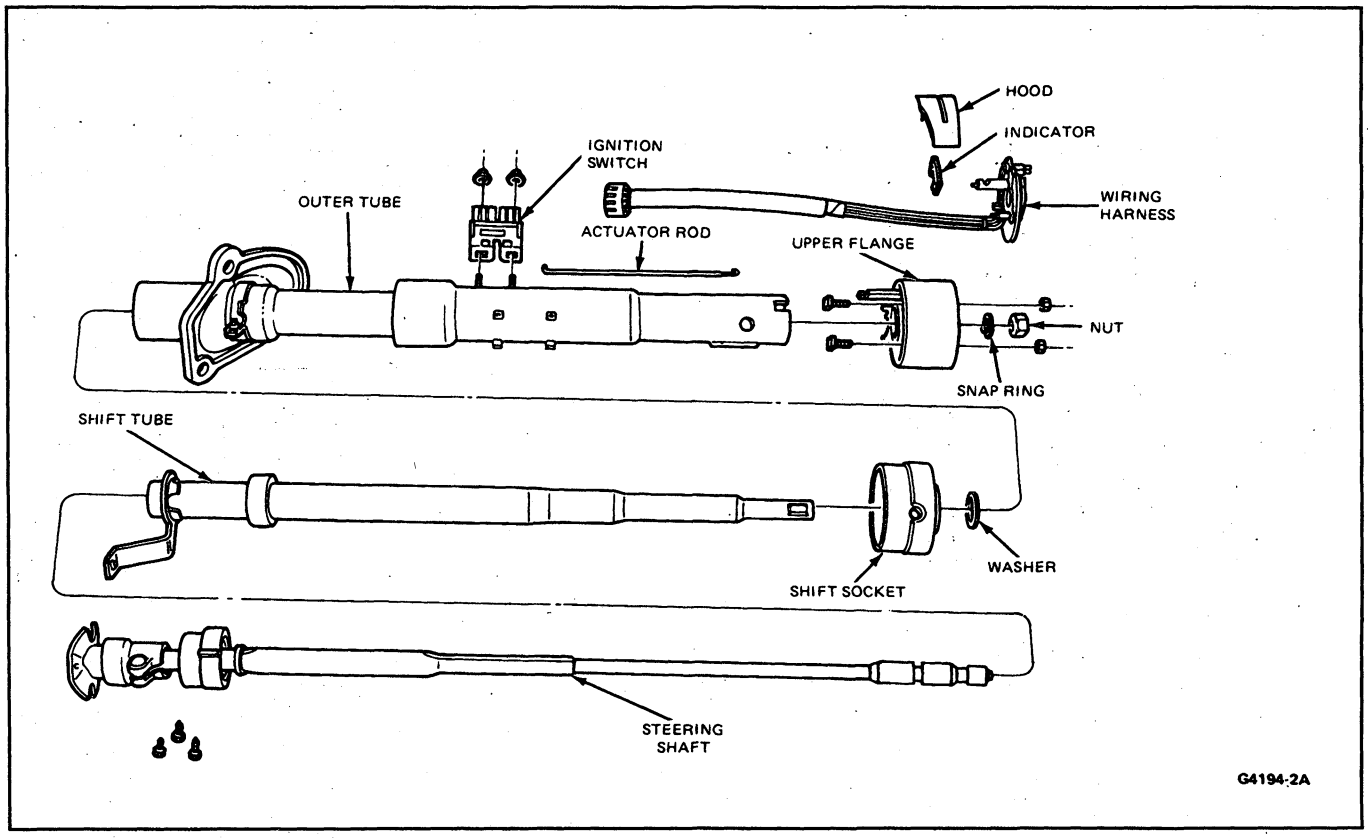


FIG. 19 Non-Tilt Steering Column With Automatic Transmission—E-150—E-350

12. Loosen upper flange retention nuts until one or two threads remain engaged. Pinching nuts toward each other, withdraw upper flange from outer tube.
13. Remove shift socket (automatics) or flange extension (manual 4-speeds), from outer tube.
14. Remove upper bearing and insulator cover from upper flange by gently tapping from opposite side.
15. Disassemble the lower bearing retainer as described in this Section.

Assembly

1. Place bushing in socket retainer in outer tube (3-speed).
2. Place bushing on upper hub and wave washer on lower hub of shift socket (3-speed).
3. Install shift socket in outer tube (automatics).
4. Install flange extension on outer tube (manual 4-speed).
5. Subassemble upper flange as described in this Section.
6. Place wave washer in flange hub on automatics.
7. Install subassembled flange onto outer tube by pinching nuts toward each other and pressing flange in place. Retaining bolt "T" head will engage cutouts in outer tube as the nuts are drawn tight. Tighten to 7-8.4 N·m (60-75 in-lbs).
8. Assemble shift tube assembly to shift collar on automatic using pop-rivet (387895 or equivalent) only.
9. Install steering shaft clip below knurl for upper bearing.
10. On F-150—F-350, Bronco and F-Super Duty only, check shaft assembly length to be 90.42 cm (35.6 inch). Adjust by gentle tapping in the appropriate direction.
11. Load shaft up through bottom of column, taking care not to collapse steering shaft on F-150—F-350 and Bronco.
12. Place cover insulator onto upper bearing and press onto knurl of steering shaft until snap ring groove is visible above bearing.
13. Install snap ring on steering shaft in groove above bearing.
14. Install turn signal-hazard warning switch and key warning buzzer terminal and tighten to 1.7-2.8 N·m (15-25 in-lbs).
15. Subassemble lower bearing retainer as described in this Section.
16. On F-150—F-350, Bronco and F-Super Duty, install lower bearing retainer making sure that the centerline of the coupling shaft attachment hole extends 20.3mm (0.8 in.) below the lower face of the retainer and tighten to 1.4-2.3 N·m (12-20 in-lbs). Minor adjustments in length can be made by gently tapping the shaft in the appropriate direction. On E-150—E-350, install the lower bearing retainer and telescope the steering column lower bayonet shaft (Fig. 21) fully towards the column lower end.

    NOTE: Apply Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent to lower bayonnet flange before installing into column.
17. Install the ignition switch actuator rod.

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18. Mount the ignition switch and hand start the switch retaining nuts with the lock cylinder in lock position.
19. Center the switch within the available range of free-play.
20. Tighten the switch retaining nuts to 4.5-7.3 N·m (40-65 in-lbs), and remove clip.
21. Install the hand shift lever and secure by driving in the pivot pin.
22. Install the turn signal switch lever and tighten to 3.4-5.1 N·m (30-45 in-lbs).

Tilt Column

Disassembly

1. Remove the column as described in this Section and clamp in vise.

   CAUTION: Clamping is permitted only on the upper tube. Care is to be taken not to permanently deform the tube wall. Permanent deformation may affect column performance during an accident.
2. Remove the turn signal lever. Drive out the pivot pin and remove the shift lever (automatics).
3. Remove the lower bearing retainer.
4. To remove the shift tube and/or socket, remove the shift tube retaining rivet from the bottom of the shift socket and withdraw the shift tube from the bottom of the column, (automatics).
5. Remove the lock drive gear as described in this Section.
6. Remove the screws securing the turn signal switch and key warning buzzer terminal. Remove the wiring harness-to-steering column tube clips (if required). Remove the turn signal switch and wiring harness from the steering column.
7. Remove the cover casting screws. Lift the cover casting up and over the steering column upper shaft, and remove the casting from the column. Unhook the upper actuator from the lower actuator and remove.
8. Remove and discard the screws that attach the lower flange to the outer tube.
9. Loosen the ignition switch nut and washer assemblies and remove the ignition rod from the switch end.
10. Withdraw the tilt mechanism, steering shaft, and ignition actuator rod from the steering column upper end.
11. Remove the shift socket (automatics).
12. Remove 3 screws retaining the flange extension on manual 4-speeds or PRND21 ring (E-150—E-350 only) (automatics) and remove the extension or ring.
13. Remove the key release lever mechanism from the tilt mechanism (manual 4-speeds).
14. Disassemble the tilt mechanism subassembly as described in this Section.

Assembly

1. Assemble the tilt mechanism as described in this Section.
2. Attach the PRND21 or (PRN⓪D1) ring to the tilt mechanism (E-150—E-350 only) (automatics) with 3 screws. Tighten to 1.1-2.2 N·m (10-20 in-lbs).
3. Attach the key release lever mechanism to the tilt mechanism (manual 4-speed) as described in this Section.
4. Attach the flange extension to the tilt mechanism with 3 screws. Tighten to 1.1-2.2 N·m (10-20 in-lbs).
5. Install the shift socket (automatics).
6. Install the tilt mechanism, feeding the steering shaft down the center of the column and the ignition actuator rod through the shift socket/lower flange extension along the top of the column outer tube. Since the steering shaft is a telescoping type, care should be taken not to change the length of the shaft.
7. Install the 3 flange retainer assemblies using new Allen head screws. Tighten to 5.6-7.7 N·m (50-68 in-lbs). Always use new Allen head screws to be sure the epoxy cement bonds properly.

   Install the lower bearing retainer as described in this Section.
8. Attach the ignition switch loosely to the outer tube.
9. Connect the upper and lower actuators. Install the cover on the column. Tighten the 3 screws to 4.5-5.6 N·m (40-50 in-lbs).
10. Install the turn signal switch and wiring harness in the steering column. Attach the key warning buzzer terminal and wiring harness-to-steering column tube clips (if required). Install the two screws that attach the turn signal switch to the flange casting and the one screw that attaches the warning buzzer terminal. Tighten the screws to 2.3-3.4 N·m (20-30 lb-in) for the turn signal switch.
11. Install the turn signal lever.
12. Install the lock drive gear.
13. Install the lock cylinder with the key in the ON position. Install the retaining pin flush with the cylinder.
14. Center the ignition within the available range of free play. Tighten the nuts.
15. Install the hand shift lever and pivot pin (automatics).
16. Install the steering column as described in this Section.

Non-Tilting Steering Column Flange and Locking Mechanism Subassembly

Refer to Fig. 8.

Disassembly

1. Remove nuts and bolts retaining flange to steering column.
2. Remove lock release lever snap ring (manuals).
3. Remove lock release lever and spring.
4. On automatic transmission remove PRND21 insert from front of flange.
5. With the lock cylinder in the "ON" position, depress the retaining pin and remove the lock cylinder.
6. Remove the lock bearing snap ring.

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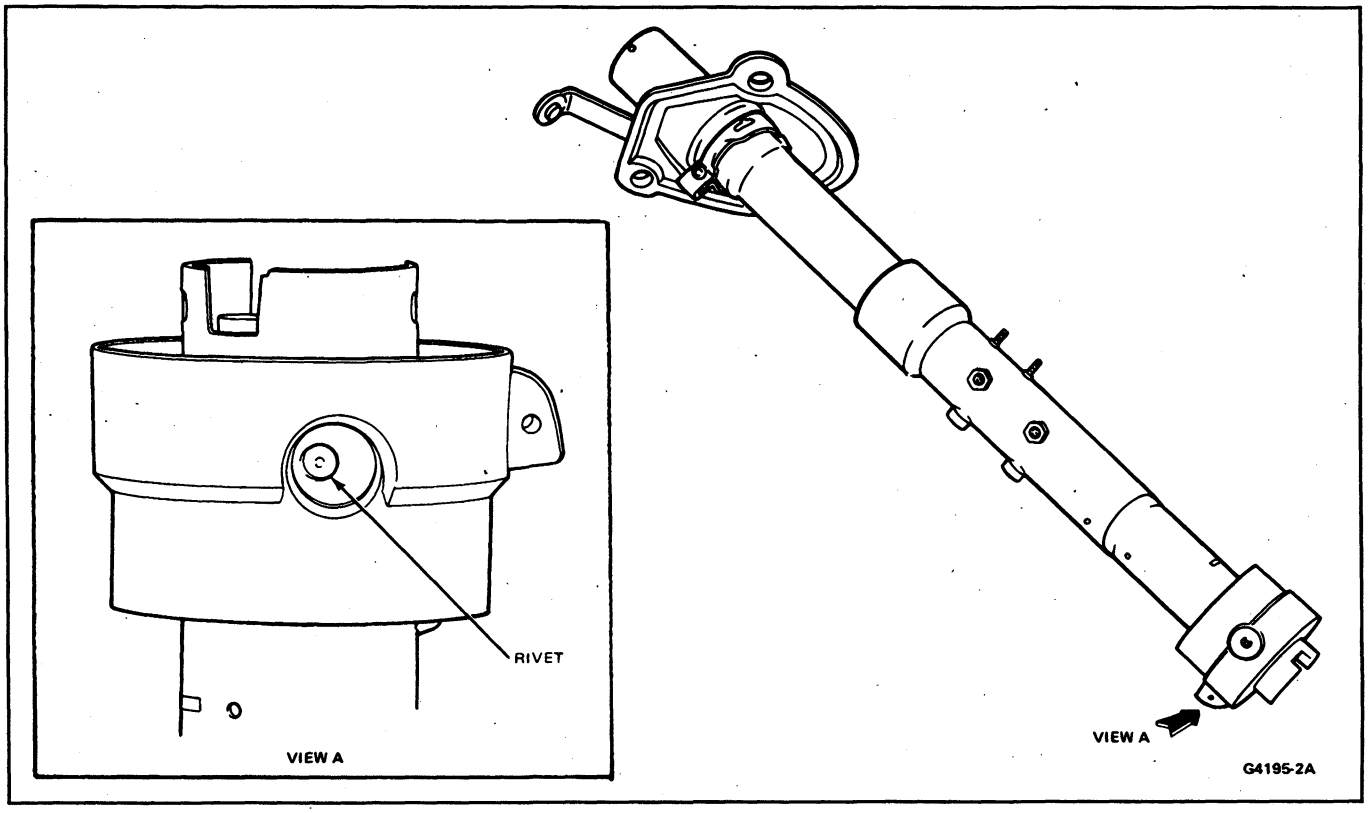


FIG. 20 Rivet Removal—Non-Tilt Steering Column—Automatic Transmission

7. Remove the lock bearing.
8. Remove the lock drive gear.
9. Remove lock actuator retaining screw.
10. Remove lock actuator.

Assembly

1. Install lock actuator insert in rear of flange and tighten screw. Tighten to 1.7-2.8 N·m (15-25 in-lbs).
2. Insert lock actuator assembly through opening in front of flange until it bottoms against insert.
3. Install lock drive gear through lock cylinder opening such that the last gear tooth aligns, with the last tooth on the actuator assembly when the actuator is fully rearward.
4. Install the lock bearing.
5. Install the lock bearing snap ring.
6. With the lock cylinder in the "ON" position and the retaining pin depressed. Insert the lock cylinder into the flange.
7. Attach PRND21 insert to front of flange on automatic transmissions.
8. Position spring on lock release lever assembly and position lever assembly through hole in front of flange on manual transmissions. Tighten spring until lever assembly is allowed to drop into place.
9. Install snap ring on lock release lever assembly (manuals).
10. Install flange retaining bolts through holes in flange and hand start nuts 1 to 2 threads on rear side.

Tilt Mechanism Upper Shaft, Bearings, and Flange Sub-Assembly

Service of this mechanism requires the steering column to be removed from the vehicle and disassembled on the bench to remove the tilt mechanism.

Disassembly

1. Remove the spring clips holding the wire bale which acts as a release lever for the locking lever. Remove the wire bale (Fig. 22).
2. With a small drift, drive out the pin holding the locking lever. Remove the lever and spring. Use a C-clamp to relieve tension on the pin if necessary.
3. Remove the column upper shaft snap ring.
4. The upper and lower flange castings can now be separated by removing the two pivot pins located in the side of the casting assembly with Tools T70P-3D739-A Pivot Pin Remover and T67P-3D739-C Pivot Pin Remover Handle (Fig. 23).
5. Do not use the pivot pins again if the press fit is loose in the lower flange.

For Bearing Or Upper Flange Service:

6. Place the flange casting on a bench with the smaller bearing facing down.
7. With a small pick, lightly tap on the outer race of the small bearing at each slot. Never drive or apply pressure of any kind to the inner race of the bearing.
8. Invert the flange casting and place it on a bench with the large upper bearing facing down.

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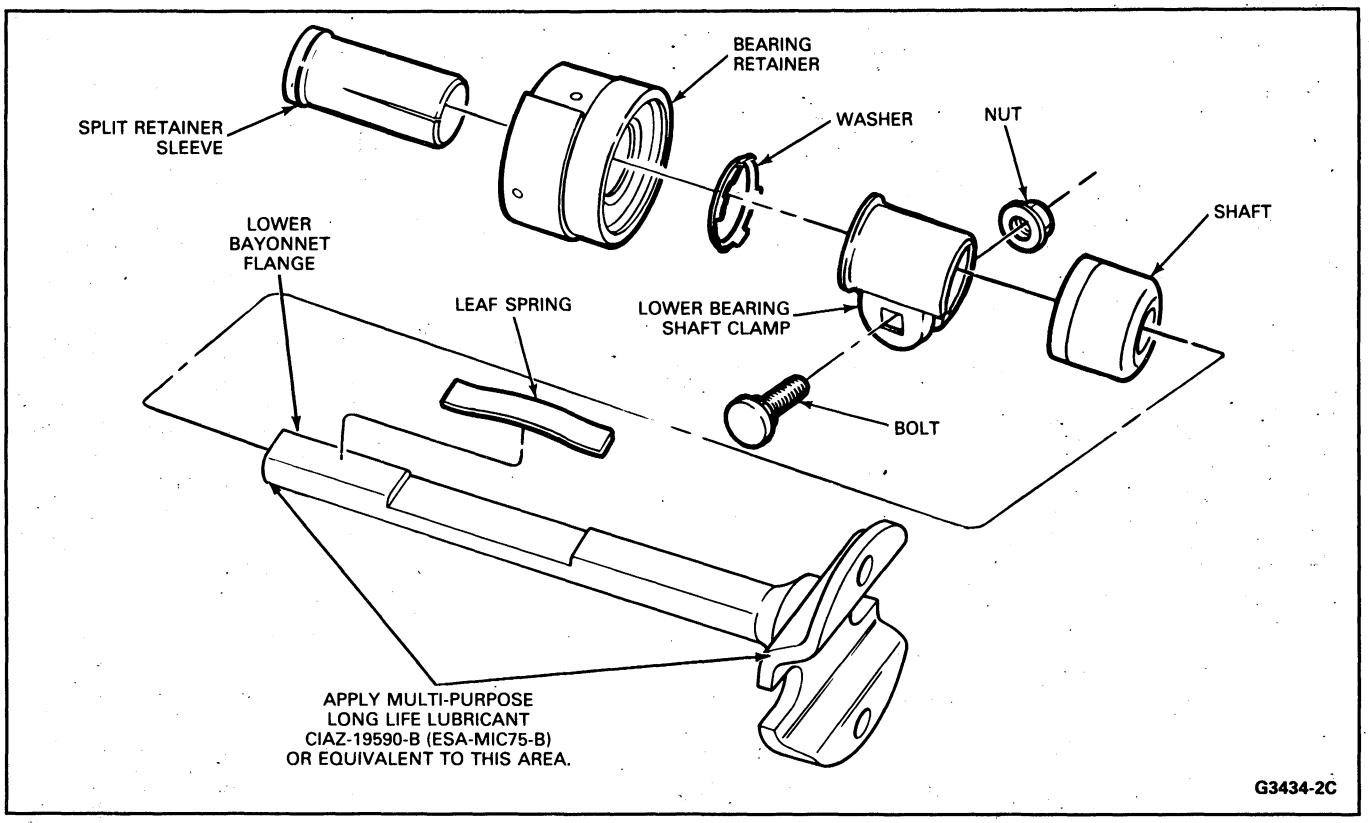


FIG. 21 Lower Bearing Retainer—Exploded View—E-150—E-350

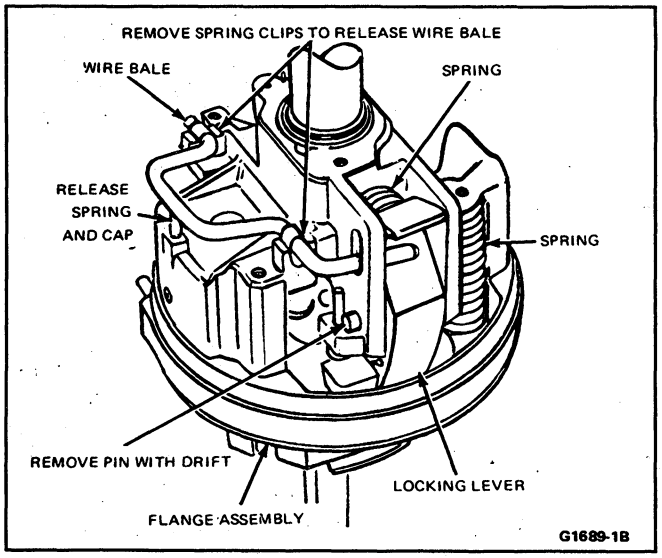


FIG. 22 Removing Wire Bale and Tilt Locking Lever

9. With a small pick, lightly tap on the outer race of the large bearing at each slot. Never drive or apply pressure of any kind to the inner race of the bearing.

Assembly

1. Position the flange casting on a bench with the large bearing seat facing upward.
2. Select a socket wrench that is the same diameter as the outer race of the large upper bearing.
3. Position the large upper bearing over its bearing seat with the open side facing inward.
4. Place the socket wrench on the outer race of the bearing and lightly tap on the socket wrench until the bearing is in place. Be careful not to contact the bearing inner race as damage will result.
5. Invert the flange casting and place it on a bench with the small bearing seat facing upward.
6. Select a socket wrench that is the same diameter as the outer race of the small bearing.
7. Position the small bearing over its bearing seat with the open side facing inward.
8. Place the socket wrench on the outer race of the bearing and lightly tap on the socket wrench until the bearing is in place. Be careful not to contact the bearing inner race as damage will result.

Tilt Mechanism Assembly

1. Install the lower actuator with the ignition switch rod attached.
2. Install the upper and lower flange with the two pivot pins (Fig. 24). Be sure the column position spring is properly seated between the upper and lower flange, and the wavy thrust washer is positioned properly between the lower flange and the socket. Do not re-use loose pivot pins.
3. Install the column upper shaft snap ring.
4. Assemble the locking lever and spring, and insert the pin that holds the lever. Use C-clamp to relieve the tension on the pin, if necessary.
5. Place the wire bale on the upper casting and install the spring clips that hold the bale in place (Fig. 21).

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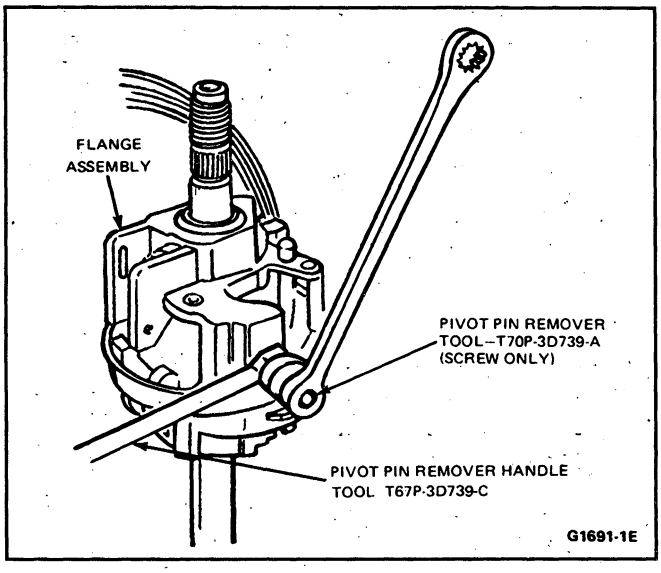


FIG. 23 Removing Pivot Pin

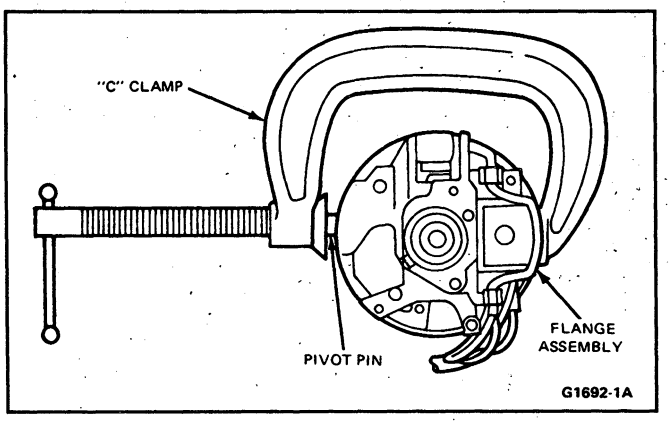


FIG. 24 Installing Flange Assembly Pivot Pins

Steering Column Lower Bearing Retainer Subassembly

E-150—E-350

Refer to Fig. 21.

Disassembly

1. Remove the steering column from the vehicle as described in this Section.
2. Remove the steering column lower bayonet flange and leaf spring.

   NOTE: Do not loosen the leaf spring.
3. Remove the lower bearing shaft clamp, bolt and nut.
4. Remove (3) screws and the lower bearing assembly.
5. Remove the split retainer sleeve from the lower bearing retainer assembly.

Assembly

1. Install the split retainer sleeve into the lower bearing retainer assembly with the sleeve shoulder against the bearing.
2. Loosely assemble the clamp, bolt and nut to the lower bearing retainer assembly. Make sure that the bolt aligns with the round groove in the split retainer sleeve.
3. While pushing down on the split retainer sleeve shoulder and the clamp up towards the bearing, tighten the clamp nut to 13-24 N·m (9-18 ft-lbs).

   NOTE: This step is extremely important to eliminate lash.
4. Install the lower bearing retainer assembly to the column outer tube. Tighten the (3) screws to 1.4-2.3 N·m (12-20 in-lbs).
5. Apply grease to the steering column lower flange bayonet and leaf spring. Assemble and install the flange fully telescoped into the column lower end.
6. Slide seal forward over the flange in the shaft clamp.
7. Install the steering column into the vehicle as described in this Section.

Steering Shaft and Anti-Rattle Clips

Non-Tilting Column

Disassembly

1. Remove the steering column assembly as described in this Section.
2. Secure the steering column assembly in a vise.
3. Remove the upper shaft bearing as described in this Section.
4. Working from the bottom of the column, remove the steering shaft.
5. Draw a mark on the lower shaft where the upper and lower steering shaft sections form a joint line.
6. Separate the upper and lower steering shaft sections.
7. Remove and discard the two steel anti-rattle clips.

Assembly

1. Install new anti-rattle clips. Be sure both are installed in the same direction.
2. Liberally lubricate the lower six inches of the end of the upper shaft.
3. Secure the lower shaft in a vise. Install the upper shaft to the mark on the lower shaft.
4. Working from the bottom of the column, install the shaft into the column from the bottom.
5. Install the upper shaft bearing.
6. Install the steering column assembly as described in this Section.

Tilt Column

Disassembly

1. Remove the steering column assembly as described in this Section.
2. Secure the steering column assembly in a vise.
3. It is not necessary to remove the turn indicator switch and wiring harness from the steering column.
4. Working from the top of the column, remove the steering shaft and tilt mechanism.
5. Draw a mark on the lower column where the upper and lower steering shafts form a joint line.

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6. Separate the upper and lower steering shafts.
7. Remove and discard the two steel anti-rattle clips.

Assembly

1. Install new anti-rattle clips. Be sure both are installed in the same direction.
2. Lubricate the lower end of the upper shaft.
3. Secure the lower shaft in a vise and install the upper shaft to the mark on the lower shaft.
4. Install the steering shaft assembly and the tilt mechanism.
5. Install the steering column assembly as described in this Section.

SPECIFICATIONS

STEERING COLUMN-SHIFT ROD WITHIN TUBE — TORQUE LIMITS
E-150 — E-250 — E-350, F-150 — F-250 — F-350, BRONCO AND F-SUPER DUTY

Description	Model	Torque (ft-lbs)	Torque (N-m)
Steering Column Coupling Flange Nuts	E-150 — E-250 — E-350	14-21	19-28
Steering Column To Support Bracket Bolts	E-150 — E-250 — E-350	19-27	26-37
Steering Column Floor Opening Cover Plate to Dash Panel Bolts	E-150 — E-250 — E-350	12-18	16-24
Steering Column Opening Cover Clamp Bolt	E-150 — E-250 — E-350	12-18	16-24
Steering Column Cover Plate Clamp Bolt	F-150 — 350, Bronco and F-Super Duty	8-18	11-24
Steering Wheel to Steering Shaft Nut	All	30-42	41-56
Intermediate Shaft Pot Joint to Steering Column Nut	F-150 — 350, Bronco and F-Super Duty	35-50	47-68
Intermediate Shaft Flex Coupling to Steering Gear Bolt	F-150 — 350, Bronco and F-Super Duty	25-34	34-46
Steering Column Support Bracket Nuts	F-150 — 350, Bronco and F-Super Duty	13-38	18-51
Floor Opening Cover Plate	F-150 — 350, Bronco and F-Super Duty	6-10	8-14
Lower Bearing Retainer Clamp Nut	E-150 — E-250 — E-350	9-18	13-24
Pedal Support Bracket Bolts	F-150 — 350, Bronco and F-Super Duty	19-27	26-37
Description	**Model**	**Torque (in-lbs)**	**Torque (N-m)**
Selector Indicator Cable Bracket Screw	F-150 — 350, Bronco and F-Super Duty	20	2.25
Steering Wheel Horn Cover Pad Screws	All	7-11	0.8-1.2
Steering Column Shroud Screw	F-150 — 350, Bronco and F-Super Duty	10-15	1.1-1.7
Upper Bearing Retainer to Column Outer Tube	F-150 — 350, Bronco and F-Super Duty	12-20	1.4-2.3
Lower Bearing Retainer to Column Outer Tube	All	12-20	1.4-2.3
Turn Signal-Hazard Warning Switch Screws (Non-Tilt)	All	15-25	1.7-2.8
(Tilt)	All	20-30	2.3-3.4
Steering Column Flange Extension Screws (Non-Tilt)	All	15-22	1.7-2.5
(Tilt)	All	10-20	1.1-2.2
Turn Signal Lever Screw	All	30-45	3.4-5.1
Subassembled Flange to Outer Tube Nuts	All	60-75	7.0-8.4
Shift Tube Retaining Nut	All	35-50	4.0-5.6
Ignition Switch Retaining Nuts	All	40-65	4.5-7.3
Flange Retainer Allen Head Screws (Tilt)	All	50-68	5.6-7.7
Column Cover (Tilt)	All	40-50	4.5-5.6
PRND21 or PRN D DI Ring to Tilt Mechanism Screws	E-150 — E-250 — E-350	10-20	1.1-2.2
Lock Actuator Insert in Rear of Flange Screws (Non-Tilt)	All	15-25	1.7-2.8

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SPECIAL SERVICE TOOLS

Number	Description	Application
T70P-3D739-A	Pivot Pin Remover	Tilt Column
T67P-3D739-C	Pivot Pin Remover Handle	Tilt Column — Use with Pivot Pin Remover
T67L-3600-A	Steering Wheel Puller	Universal

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SECTION 13-07 Steering Column—Stripped Chassis Models

SUBJECT	PAGE
SPECIFICATIONS	13-07-12
ADJUSTMENTS	
Ignition Switch Adjustment	13-07-2
Switch Adjustments	13-07-2
DESCRIPTION	13-07-1
DIAGNOSIS AND TESTING	13-07-1
DISASSEMBLY AND ASSEMBLY	
Steering Column Flange and Locking Mechanism Subassembly	13-07-12
Steering Column	13-07-9
REMOVAL AND INSTALLATION	
Column Lock Actuator and Steering Wheel Lock Pin	13-07-6
Ignition Lock Cylinder Assembly.	13-07-6
Ignition Lock Drive Gear	13-07-8
Steering Column	13-07-3
Steering Wheel	13-07-2
Upper Shaft Bearing, Upper Flange and Shift Socket/Flange Extension	13-07-5
VEHICLE APPLICATION	13-07-1

VEHICLE APPLICATION

F-Super Duty Commercial Stripped Chassis, Motor Home Chassis and E-350 Stripped Chassis Vehicles.

DESCRIPTION

The steering columns are attached to the steering gear by means of a coupling shaft. The column design features a concentric outer tube, internal shift tube for automatic transmission selection, and steering shaft.

Two types of column are used; a manual transmission-type column and a automatic transmission type column. the shifter unit is built into the automatic transmission column.

Features on the column include an emergency flasher switch and a turn signal indicating switch with lane change position.

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service for diagnostic and testing procedures.

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ADJUSTMENTS

Ignition Switch Adjustment

Correct Ignition Switch Operation

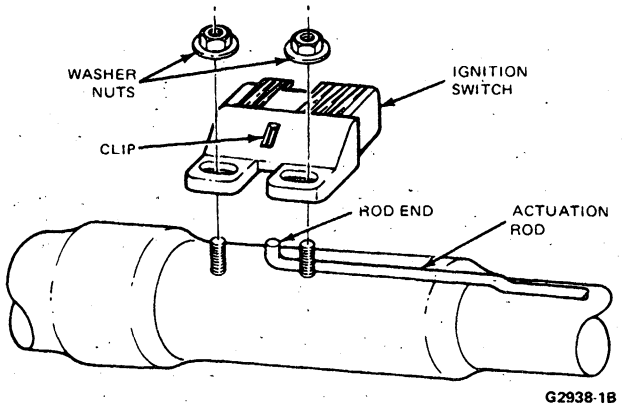
The ignition switch is actuated by a rod through the lock actuator rack and pinion driven by the key cylinder. Rotating the key clockwise from the full counterclockwise stop, the positions are: ACCESSORY, LOCK, OFF, ON, and START, if the switch is properly adjusted.

1. In ACCESSORY, the accessory circuits are operative.
2. In LOCK, all ignition switch electrical circuits are inoperative and the steering wheel and gear shift lever are locked.
3. In OFF, all ignition switch electrical circuits are inoperative and the steering wheel is unlocked for all gear shift lever positions.
4. In ON, all ignition switch circuits are operative except the starter circuit and the steering wheel is unlocked.
5. In START, the engine ignition and starter circuits only are operative and the steering wheel is unlocked.
6. The above function are attainable regardless of direction of actuation.

If the above operations are not acquired, adjust per procedures below.

Switch Adjustments

1. Place the key in the ignition switch and rotate to LOCK Position.
2. Loosen the washer-nuts retaining the ignition switch to the steering column.
3. Align the clip hole in the ignition switch with the actuation rod end.
4. Center the switch on the actuation rod.
5. Tighten the washer nuts to 4.5-7.3 N·m (40-65 in lbs) and remove the clip.
6. Check for correct ignition switch operation.



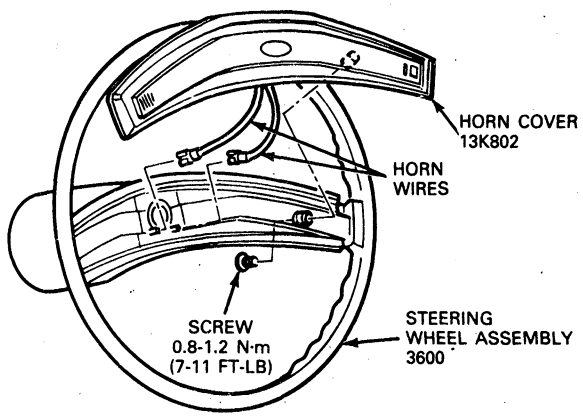
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REMOVAL AND INSTALLATION

Steering Wheel

Removal

1. Park the vehicle with the front wheels in the straight ahead position. Mark the steering wheel in relationship to the steering column with chalk or two pieces of tape.
2. Disconnect the battery ground cable.
3. Remove one screw from the underside of each steering wheel spoke, and lift the horn switch assembly (steering wheel pad) from the steering wheel.



G6540-1A

4. Disconnect the horn switch wires by pulling the spade terminal from the blade connectors.
5. Remove the horn switch assembly.
6. Remove steering wheel retaining nut.
7. Use the Steering Wheel Puller, T67L-3600-A or equivalent and remove steering wheel from shaft. Do not hammer on the steering wheel or center shaft or use a knock-off type steering wheel puller as either procedure will damage the steering column.

Installation

The steering wheel can be installed in one position.

Place the steering wheel on the steering column upper shaft, so that the mark and flat on the steering wheel is in line with the mark and flat on the steering column center shaft.

1. Install a steering wheel lock nut (389530-S2 or equivalent). Tighten the nut to 41-57 N·m (30-42 ft-lb).
2. Connect the horn wires.
3. Install the steering wheel horn cover pad. Tighten the screws to 0.81-1.2 N·m (7-11 in-lbs).
4. Connect the negative (-) battery cable to the terminal.
5. Test the steering column for proper operation.

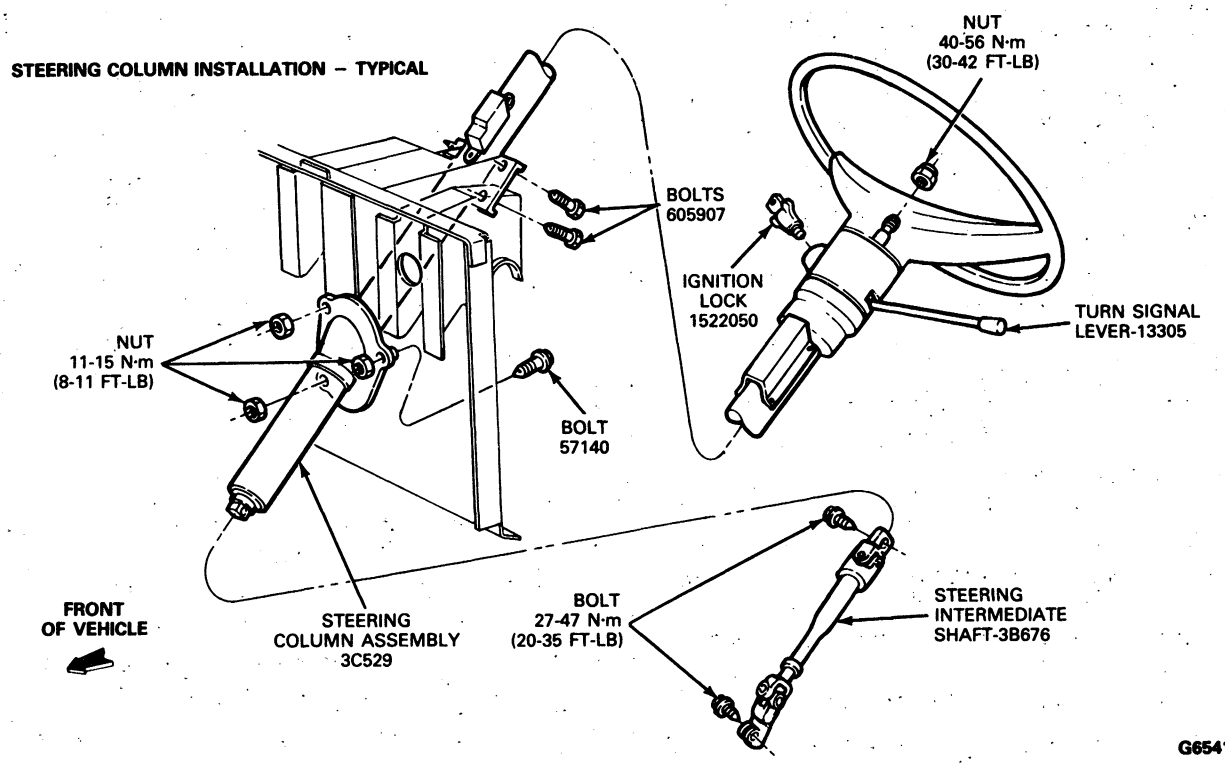
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REMOVAL AND INSTALLATION (Continued)

Steering Column

Removal

1. Park the vehicle with front wheels in a straight ahead position.
2. Disconnect the battery ground cable.
3. Remove the intermediate shaft to steering column shaft clamp bolt.
4. Disconnect the transmission shift linkage rod from the column (vehicles with automatic transmission only).
5. Remove the steering wheel as described above.
6. Disconnect the turn signal, hazard warning, ignition switch and horn wiring harness from the column.
7. Remove the steering column to floor pan cover plate retaining bolts.
8. Remove the steering column to steering column support bracket retaining bolts and remove the steering column from the vehicle.

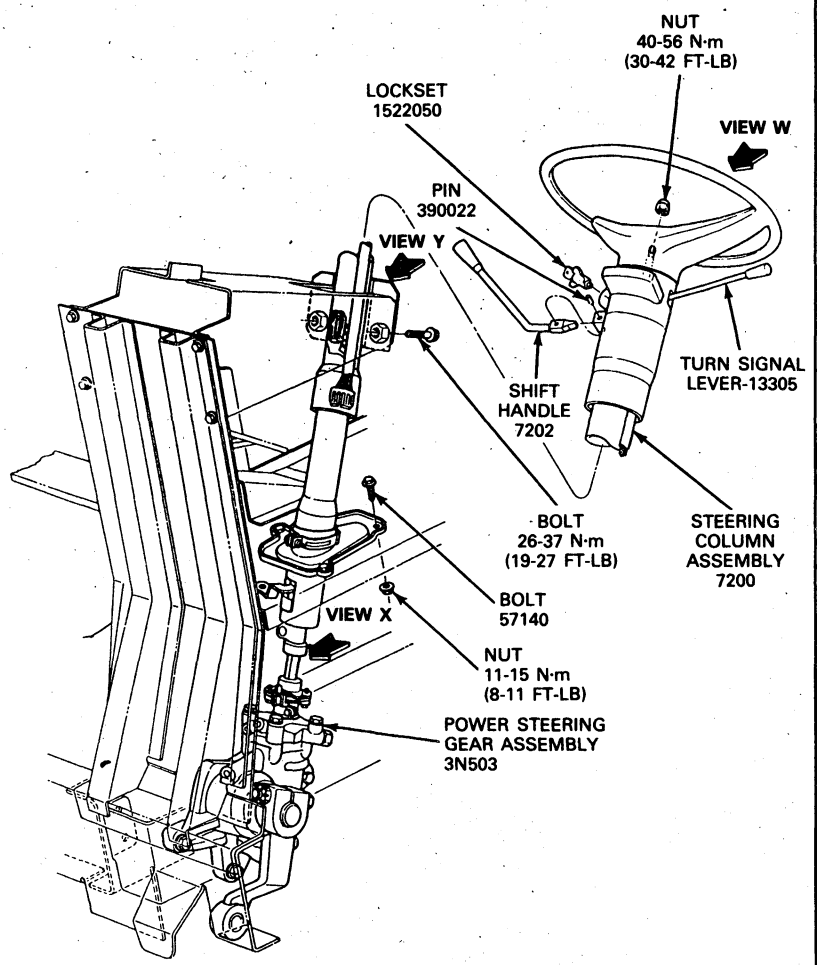


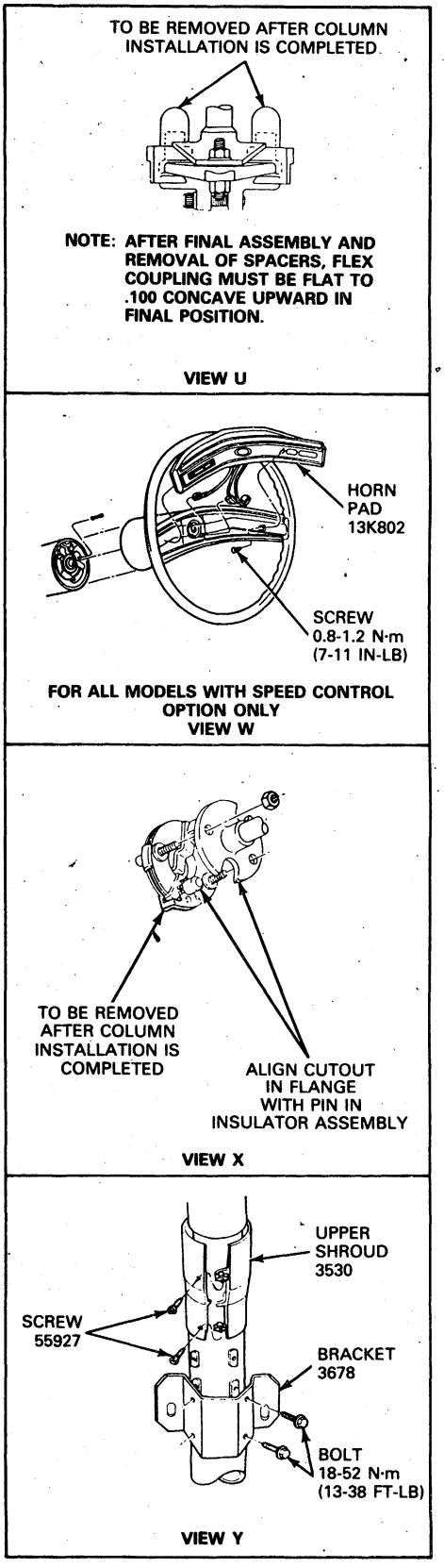
Installation

1. Place the steering column in the vehicle.
2. Attach the turn signal, hazard warning, ignition switch and horn wiring harness to the column terminal.
3. Install steering column to support bracket with the two bolts and tighten to 11-27 N·m (8-20 ft-lb) for E-350 Stripped Chassis vehicles and 26-37 N·m (19-27 ft-lb) for F-Super Duty Stripped Chassis vehicles.
4. Attach intermediate shaft to column. Tighten clamp bolt to 50-80 N·m (40-60 ft-lbs) for E-350 Stripped Chassis vehicles and 27-47 N·m (20-35 ft-lb) for F-Super Duty Stripped Chassis vehicles. Make sure that bolt is aligned in the shaft groove.
5. Attach lower seal and retainer assembly to dash panel with three bolts and tighten to 16-23 N.m (12-27 ft-lb) for E-350 Stripped Chassis vehicles and 11-15 N·m (8-11 ft-lb) for F-Super Duty Stripped Chassis vehicles.
6. Install the steering wheel back in its original position. Install and tighten the steering wheel nut to 40-56 N·m (30-42 ft-lb). Connect the horn switch wires, (if present).
7. Reinstall the shift linkage rod.
8. Reconnect the battery ground cable and test the steering column for proper operation.

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REMOVAL AND INSTALLATION (Continued)





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REMOVAL AND INSTALLATION (Continued)

Upper Shaft Bearing, Upper Flange and Shift Socket/Flange Extension

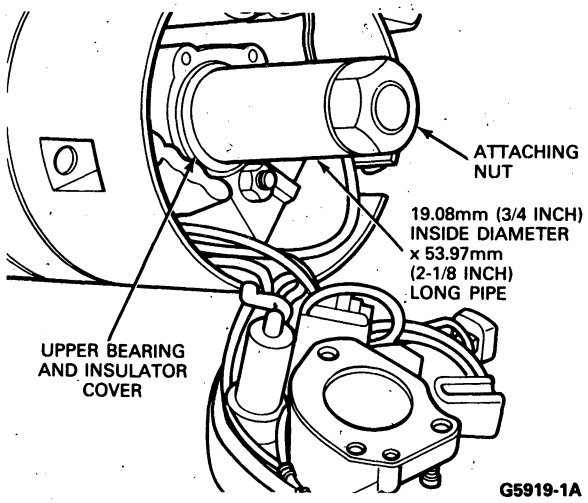
Theses components can be serviced without removing the column from the vehicle.

Removal

1. Set the parking brake.
2. Disconnect the battery cable from the negative terminal.
3. Remove the steering column shroud and instrument panel opening cover.
4. Disconnect the turn signal hazard warning and ignition switch electrical connections.
5. Clip the ignition switch in the LOCK position and remove the switch.
6. Remove the steering wheel as described in this Section.
7. If the shift socket is to be removed, drive out the pivot pin and remove the lever.
8. Remove the turn signal lever.
9. Remove the automatic transmission hood and lens, if so equipped.
10. Remove the screws from the turn signal hazard warning switch and slip the switch off the steering shaft.
11. Remove the snap ring from above the upper shaft bearing.
12. Loosen the nuts retaining the upper flange casting to the column until one or two threads on each remain engaged, pinching the nuts toward each other, withdraw the upper flange from the steering column. Some tapping on the steering shaft upper end with a light hammer may be required.
13. Remove the upper shaft bearing and insulator cover by driving out from the opposite side of the flange.
14. Remove the shift tube retaining screw at the bottom of the shift socket and withdraw the shift socket.
15. Remove the 3 flange extension retaining screws and remove the extension.

Installation

1. Install the shift socket/flange extension.
2. Place the flange on the steering column tube and tighten nuts to 6.8-8.5 N·m (60-75 in-lb).
3. Pick punch the steering shaft serration diameter to insure an interference fit to the inner face. Place the bearing and insulator on the shaft, working them as far down the shaft as possible. Place a piece of pipe 19.05mm (3/4 inch) (inside diameter) x 53-97mm (2 1/8 inch) long over the end of the shaft.
4. Install the steering wheel attaching nut. Tighten the nut until the bearing is seated in the flange. Remove the nut and pipe from the steering shaft.

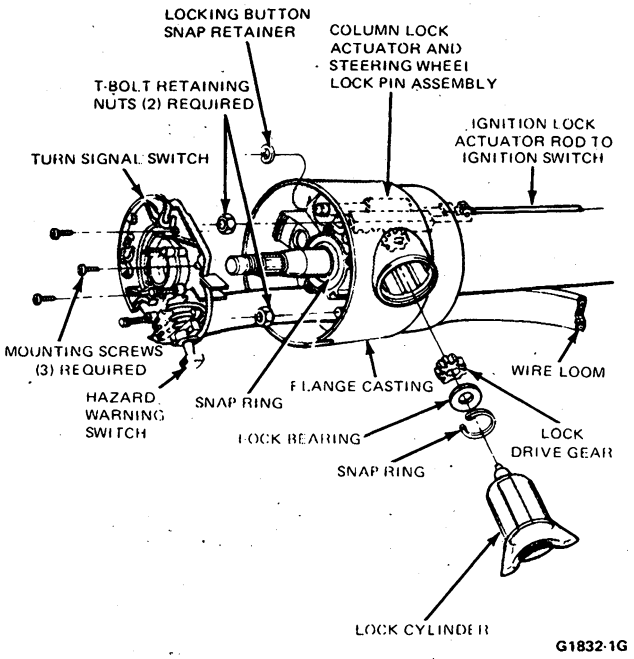


5. Install the snap ring in the groove on the steering shaft.
6. Install the turn signal switch on the flange. Tighten the screws to 2.5-3.0 N·m (20-30 in-lbs).
7. Install the turn indicator lever.
8. Connect the electrical connections to the steering column.
9. Install the steering wheel as described in this Section.
10. Connect the negative battery cable to the terminal.
11. Test the steering column for proper operation.

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REMOVAL AND INSTALLATION (Continued)

Column Lock Actuator and Steering Wheel Lock Pin



Removal

1. Remove the steering column shroud.
2. Remove the ignition lock drive gear as described in this Section.
3. Remove the attaching nuts that hold the steering column to brake pedal support.
4. Loosen the ignition switch attaching nuts and remove the ignition rod from the switch end.
5. Remove the upper shaft bearing as described in this Section,
6. Remove the ignition lock actuator rod and steering wheel lock pin assembly.
7. Remove and discard the retaining clip at the lower end of the steering wheel lock pin. Remove the steering wheel lock pin and lock pin spring from ignition switch actuator. Do not lose the spring.

Installation

1. Install a new lock pin and clip, and the old-lock pin spring in the actuator casting.
2. Place the column lock actuator and steering wheel lock pin in the steering column.
3. Engage actuator rod into ignition switch retaining nuts.
4. Install the lock drive gear, lock bearing and snap ring.
5. Install the lock cylinder with the key in the ON position. Install with the retaining pin flush with cylinder. Turn key to the OFF position.
6. Install the upper shaft bearing as described in this section.
7. Adjust the ignition switch as explained in this Section.
8. Secure the steering column to the brake pedal support.
9. Install the trim shroud.

Ignition Lock Cylinder Assembly.

NOTE: The following procedure pertains to vehicles that have functional lock cylinders and ignition keys are available or the ignition key numbers are known and the proper key can be made.

Removal

1. Disconnect the battery ground cable.
2. Remove the horn button and the steering wheel as described earlier in this Section.
3. Place the gear shift in neutral (with automatic transmission) or in any position with manual transmission and turn the lock cylinder with the ignition key to ON position.
4. Place 1/8 inch diameter wire pin or small drift punch in the hole located inside the column near the base of the lock cylinder housing and depress the retaining pin while pulling out on the lock cylinder to remove it from the column housing.

Installation

1. To install the lock cylinder, turn the lock cylinder to the ON position and depress the retaining pin, then insert the lock cylinder into its housing in the flange casting. Assure that the cylinder is fully sealed and aligned into the interlocking washer before turning the key to the OFF position. This action will permit the cylinder retaining pin to extend into the cylinder cast housing hole.
2. Using the ignition key rotate the lock cylinder to insure correct mechanical operation in all positions.
3. Install the steering wheel and trim pads as described earlier in this Section.
4. Connect the battery ground cable.
5. On vehicles equipped with automatic transmission, check for proper start in Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.

NOTE: The following procedure applies to vehicles where the ignition lock is inoperative and the lock cylinder cannot be rotated due to a lost or broken ignition key and the key number not known or the lock cylinder cap is damaged and/or broken to the extent that the lock cylinder cannot be rotated.

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REMOVAL AND INSTALLATION (Continued)

Removal

1. Disconnect the battery ground cable.
2. Remove the horn button and steering wheel as described earlier in this Section.
3. Remove the turn signal lever from the steering column.
4. To gain access to the ignition switch remove the steering column trim shrouds from the steering column. Detach and lower the steering column assembly from the brake pedal support bracket as described earlier in this Section.
5. Remove the ignition switch and pin it in the LOCK position.
6. Remove the turn signal switch from the column assembly as described in this Section under Manual Key, Release Button and Lever in the Removal and Installation Section.
7. Remove the upper bearing snap ring and the (2) T-bolt retaining nuts that secure the flange casting to the outer tube. Remove the entire flange casting assembly, the upper shaft bearing, the lock cylinder assembly, the ignition switch actuator and the ignition switch actuator rod by pulling the assembly over the end of the steering column shaft.
8. Replace the above assembly with a new assembly consisting of:

   (1) 3511 Flange

   (1) 11582 Lock Cylinder Assembly

   (1) 3E717 Lock Gear, Steering Column Lock

   (1) 3E700 Bearing, Steering Column Lock

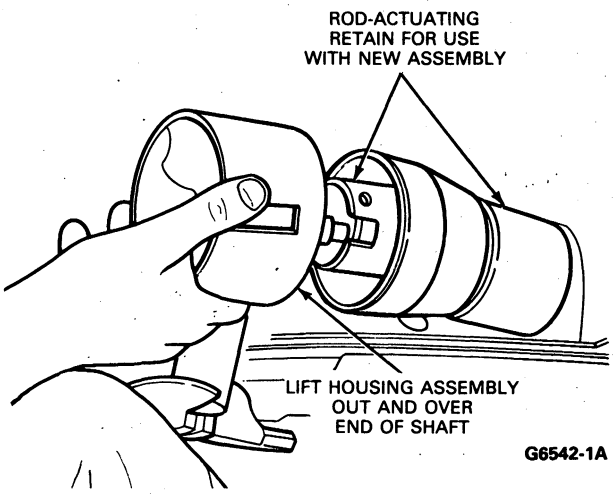
   (1) 3C610 Retainer, Steering column Upper Bearing

   (1) 3E723 Actuator Assembly, Steering Column Lock

NOTE: retain the ignition switch actuating rod from the removed casting assembly and use it with the new flange casting assembly.

Installation

1. Reassemble the above parts, installing a new upper shaft bearing (3517) and set the actuator to drive gear as described earlier in this Section.
2. Install the turn signal switch as described earlier in this Section.
3. Install the ignition switch, check and/or adjust for proper function as specified in this Section.
4. Install the instrument cluster.
5. Install the steering column trim shrouds, steering wheel and pad assembly as specified earlier in this Section.
6. Install the turn signal lever.
7. Using the ignition key rotate the lock cylinder to insure correct mechanical operation in all positions.
8. Connect the battery ground cable.
9. Check for proper start in Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.



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REMOVAL AND INSTALLATION (Continued)

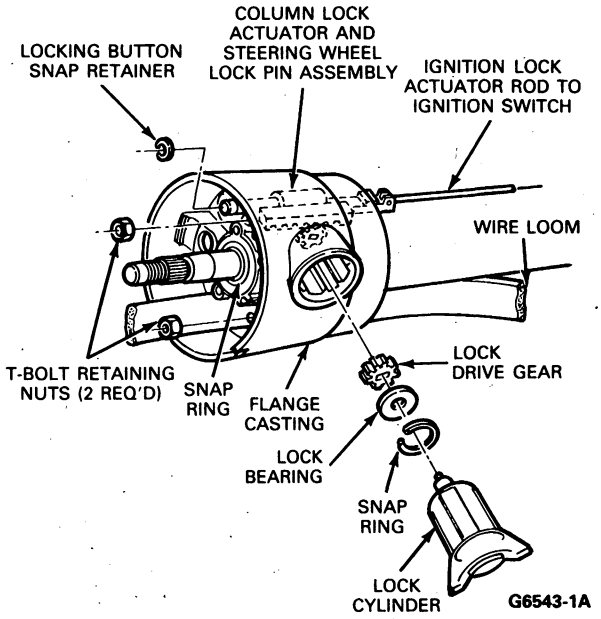
Ignition Lock Drive Gear

Removal

1. Remove the lock cylinder assembly as detailed in this Section.
2. Insert a flat bladed screwdriver in the recess of the drive gear at the bottom of the lock cylinder housing. Turn the lock drive gear counterclockwise three notches.
3. Remove the snap ring, washer and lock drive gear from the lock cylinder housing. Note the position of the drive gear to the rack teeth.

Installation

1. Install the lock drive gear in the housing in the same position as noted during removal. Installation is correct if the last tooth on the drive gear is meshed with the last tooth on the rack. Install the washer and snap ring.
2. Using the screwdriver blade, turn the drive gear clockwise three notches.
3. Install the lock cylinder.



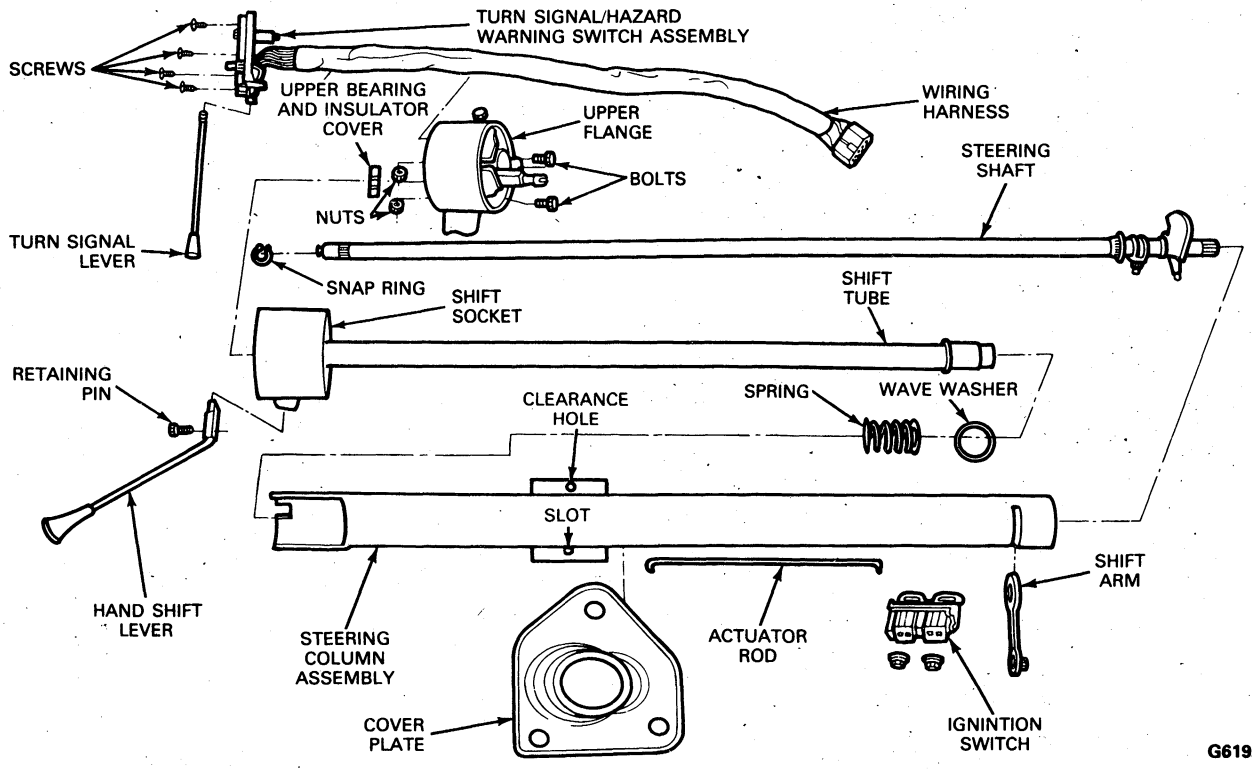
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DISASSEMBLY AND ASSEMBLY

Steering Column

Disassembly

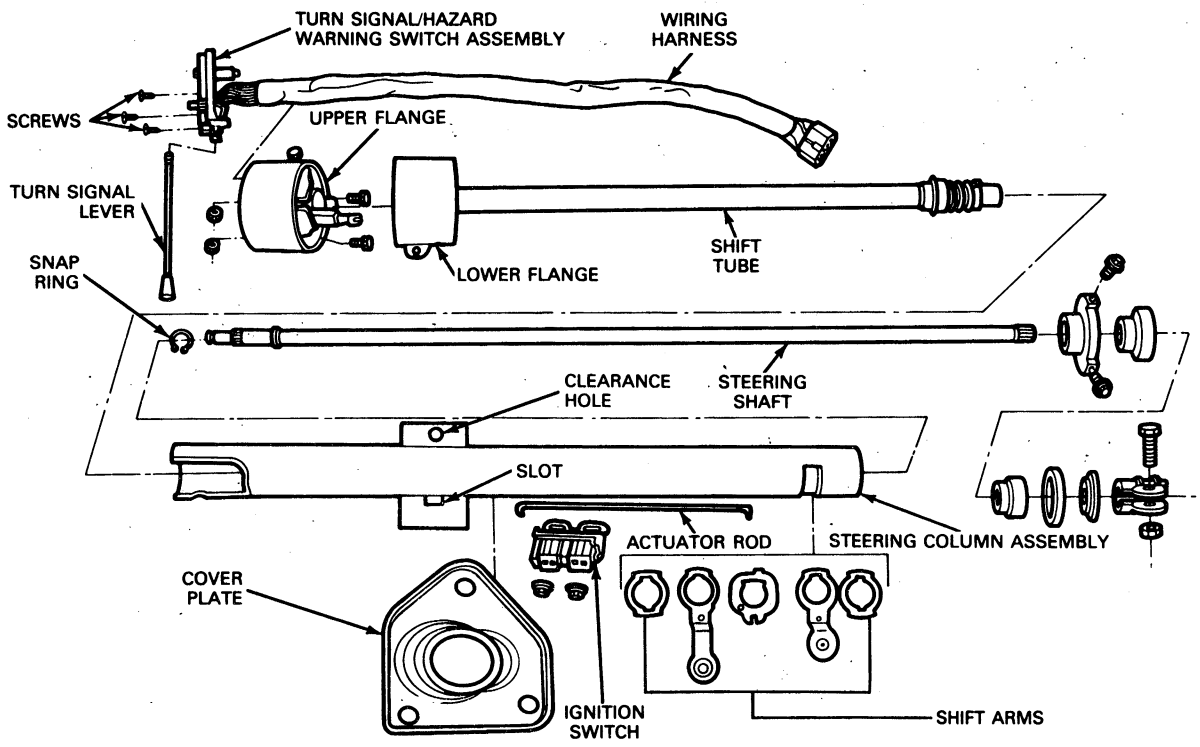
1. Remove the steering column per this Section.
2. Unscrew the turn signal lever.
3. Drive out hand shift lever pivot pin and remove hand shift lever.
4. Remove turn signal-hazard warning switch retaining screws and partially withdraw switch from upper flange.
5. Remove snap ring from steering shaft above the upper shaft bearing.
6. With a light hammer tap the steering shaft out the bottom of the steering column.
7. Clip the ignition switch in LOCK position and remove ignition switch and actuation rod.
8. Remove the automatic transmission hood and lens assembly, (if so equipped).
9. Loosen the upper flange retaining nuts until 1 or 2 threads remain engaged, pinch the nuts toward each other, and pull flange off outer tube.
10. Remove shift tube retaining bolt from the bottom of the shift socket.
11. Remove the shift/socket flange extension.
12. Remove the lower bearing retainer, if so equipped.
13. Withdraw shift tube from top or bottom of the steering column.
14. Withdraw lower shift arms and spacer from column outer tube.
15. Remove lamp from flange and separate turn signal-hazard warning switch from flange.
16. Remove upper shaft bearing and insulator cover from upper flange by tapping with light hammer from opposite side of flange.
17. Disassemble the upper flange and locking mechanism per this Section.
18. Remove the floor opening cover plate from the outer tube.



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DISASSEMBLY AND ASSEMBLY (Continued)

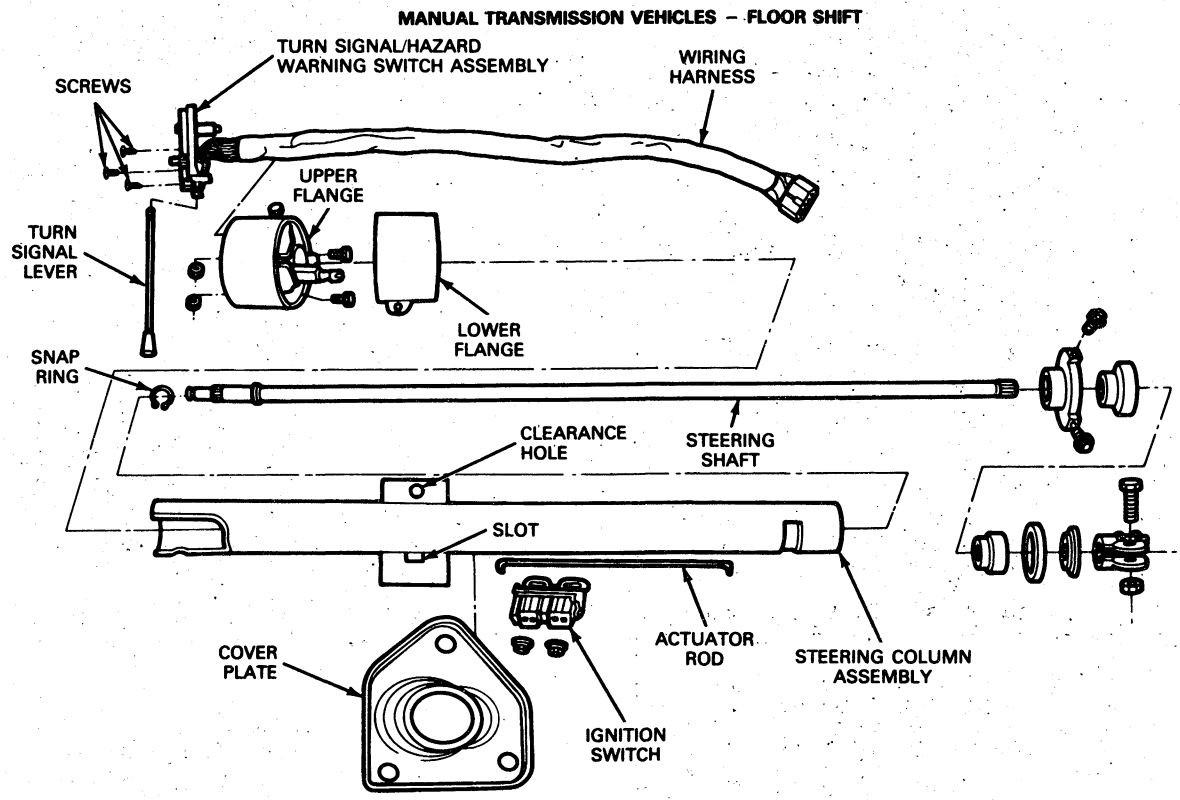
MANUAL TRANSMISSION VEHICLES – COLUMN SHIFT



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DISASSEMBLY AND ASSEMBLY (Continued)

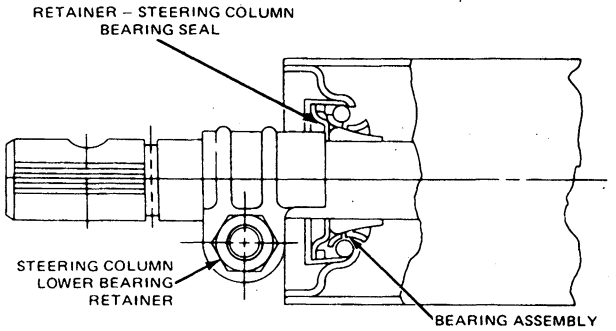


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DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

1. Place bushing in socket retainer in outer tube.
2. Place bushing on upper hub and wave washer on lower hub of shift socket.
3. Insert lower shift arms and spacer in outer tube.
4. Insert shift tube assembly from top or bottom of column.
5. Install shift socket onto shift tube in outer tube or flange extension onto outer tube 1.7-2.3 N·m (15-20 in-lbs).
6. Install shift tube retaining screw in the bottom of the shift socket.
7. Place turn signal-hazard warning switch wiring harness through flange.
8. Press lamp and wire into flange.
9. Feed turnsignal harness through shift socket. Pinching the flange casting subassembly retaining nuts toward each other, install flange.
10. Install ignition switch actuation rod, ignition switch and hand start the washer-nuts retaining the switch.
11. Adjust the ignition switch per this Section.
12. Install the steering shaft from the column bottom.
13. Install the lower bearing retainer.
14. Install the upper shaft bearing and insulator cover per this Section.
15. Install the snap ring on the shaft above the upper bearing.
16. Loosen the lower bearing retainer so it is free to slide on the steering shaft.
17. Seat the upper bearing by tapping on the upper end of the shaft with a rubber mallet.
18. Preload the lower bearing by sliding the bearing retainer against the bearing with the thumb and forefinger while holding the steering shaft. Tighten the retainer nut to 14-18 N·m (10-14 ft-lb) while holding the bearing retainer.



VIEW OF LOWER END OF STEERING COLUMN ASSEMBLY G3306-1A

19. Install the turnsignal-hazard warning switch and tighten the 3 retaining screws.
20. Install the automatic transmission hood and lens, if so equipped.
21. Install the hand shift lever and pivot pin.
22. Install the turn signal lever.
23. Install the steering column per this Section.

Steering Column Flange and Locking Mechanism Subassembly

1. Install lock actuator insert in rear of flange and tighten screw 1.7-2.8 N·m (15-25 in-lbs).
2. Insert lock actuator assembly through opening in front of flange until it bottoms against insert.
3. Install lock drive gear through lock cylinder opening such that the last gear tooth aligns with the last tooth on the actuator assembly when the actuator is fully rearward.
4. Install the lock bearing.
5. Install the snap ring.
6. with the lock cylinder in the "run" and the retaining pin depressed. Insert the lock cylinder into the flange.
7. Attach PRND21 insert to front of flange.
8. Position spring on lock release lever assembly and position lever assembly through hole in front of flange torque spring until lever assembly is allowed to drop into place.
9. Install snap rig on lock release lever assembly.
10. Install flange retaining bolts though holes in flange and hand start nuts 1 to 2 threads on rear side.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description
T67L-3600-A	Steering Wheel Remover

CG3598-1A

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SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS — F-SUPER DUTY AND E-350 COMMERCIAL STRIPPED CHASSIS AND MOTOR HOME CHASSIS VEHICLES

Description	Torque	
	N•m	Ft-Lb
Ignition Switch Retaining Nuts	4.5-7.3	40-65
Steering Wheel Horn Cover Pad	0.8-1.2	7-11
Steering Wheel Nut	40-56	30-42
Steering Column Lower Bearing Retainer	14-18	10-14
Floor Opening Cover Plate — E350	16-23	12-17
Floor Opening Cover Plate — F-Super Duty	11-15	8-11
Intermediate Shaft Lock Bolt	27-47	20-35
	N•m	In-Lb
Lock Actuator Insert Screw	1.7-2.8	15-25
Steering Column Tube Flange Nuts	6.8-8.5	60-75
Turn Signal Switch Screws	2.5-3.0	20-30

CG6544-2B

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SECTION 13-24 Steering Linkage

SUBJECT	PAGE
DESCRIPTION	13-24-1
DIAGNOSIS AND TESTING	13-24-1
REMOVAL AND INSTALLATION	
Drag Link	13-24-3
Pitman Arm	13-24-3
Steering Tie Rod	13-24-4
Tie Rod Adjusting Sleeve and Ball Stud	13-24-5
REMOVAL AND INSTALLATION (Cont'd)	
Tie Rod Adjusting Sleeve and Ball Stud (Cont'd)	
Rubberized Ball Socket Steering Linkage (R.B.S.)	13-24-5
Tie Rod and Drag Link Assembly	13-24-1
SPECIFICATIONS	13-24-7
VEHICLE APPLICATION	13-24-1

VEHICLE APPLICATION

Applies to F-150—F-350, E-150—E-350, Bronco and F-Super Duty Series Vehicles.

DESCRIPTION

Refer to Figs. 1-7.

The steering linkage is composed of Pitman arm, drag link, rod and tie rod. The Pitman arm transfers the steering gear movements through the drag link and tie rod to the spindles.

The F-150—F-350, Bronco, F-Super Duty Chassis Cab and E-150—E350 steering linkage has adjustments in both the tie rod and the drag link.

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service for diagnostic and testing procedures.

REMOVAL AND INSTALLATION

Tie Rod and Drag Link Assembly

Refer to Figs. 1-7.

Replace the drag link or tie rod if a ball stud is excessively loose, or if the tie rod or drag link is bent. Do not attempt to straighten a drag link or tie rod.

Removal

1. Remove the cotter pins and nuts from the drag link and tie rod ball studs.

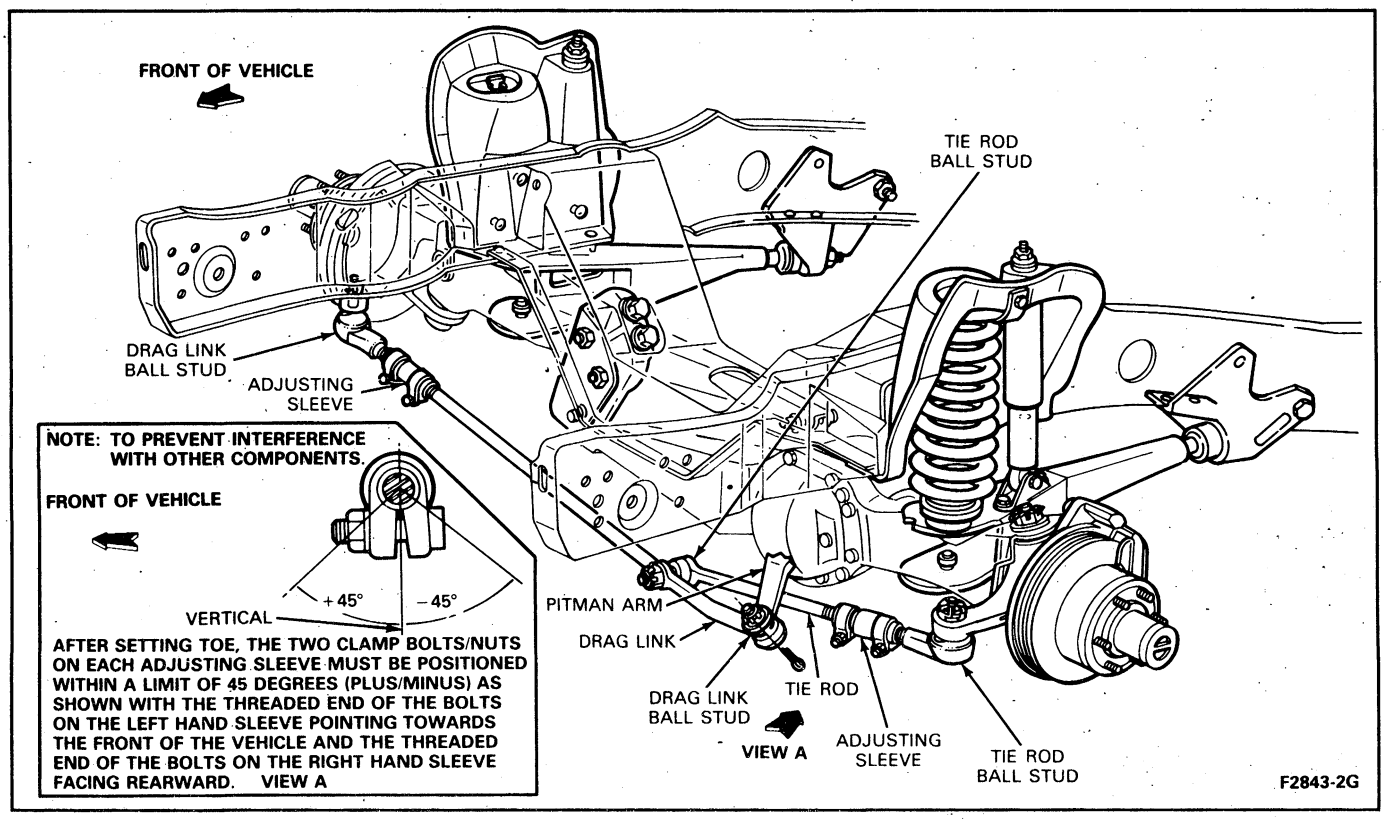


FIG. 1 Steering Linkage F-150 (4x4) and Bronco

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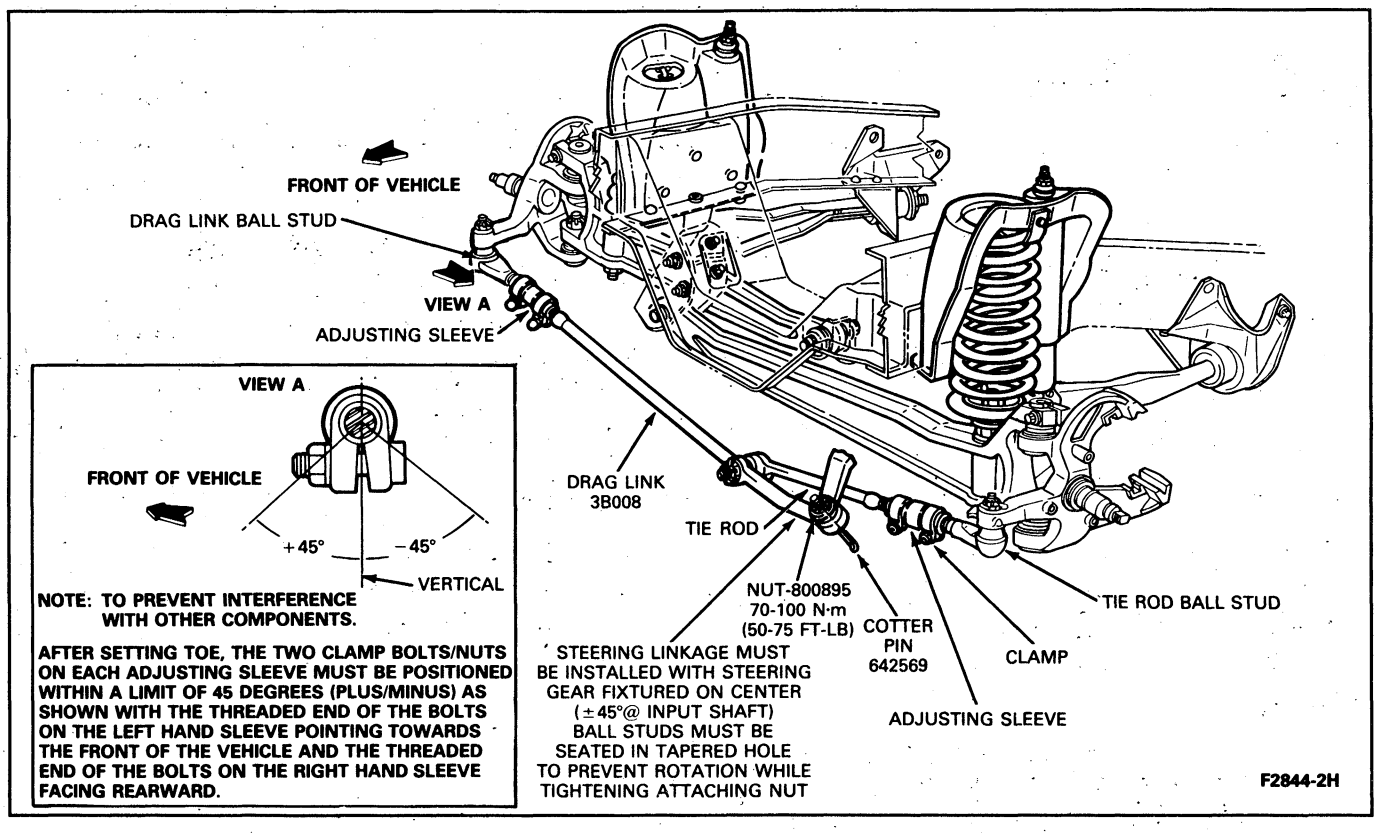


FIG. 2 Steering Linkage F-150—F-350 (4x2)

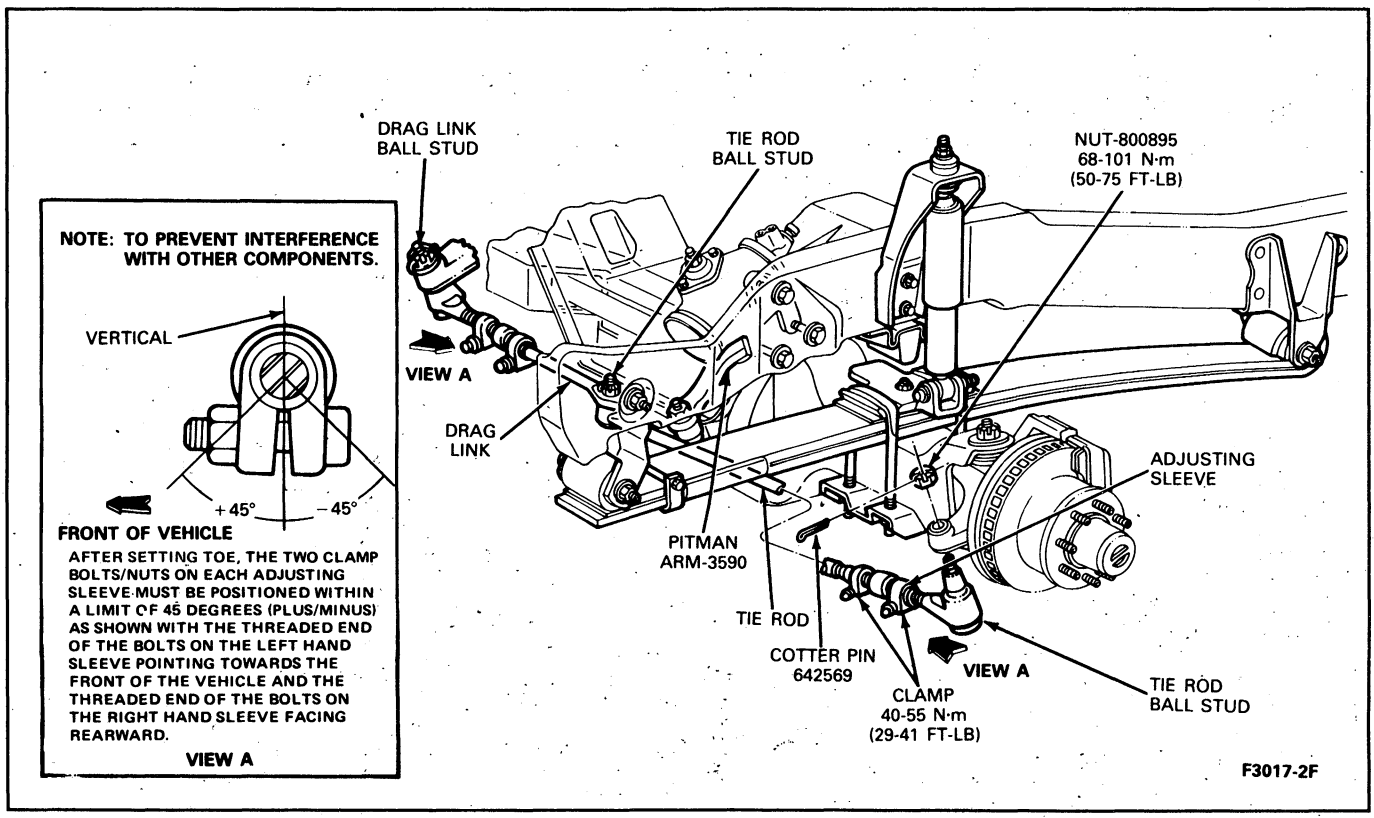


FIG. 3 Steering Linkage—F-250 (4x4)

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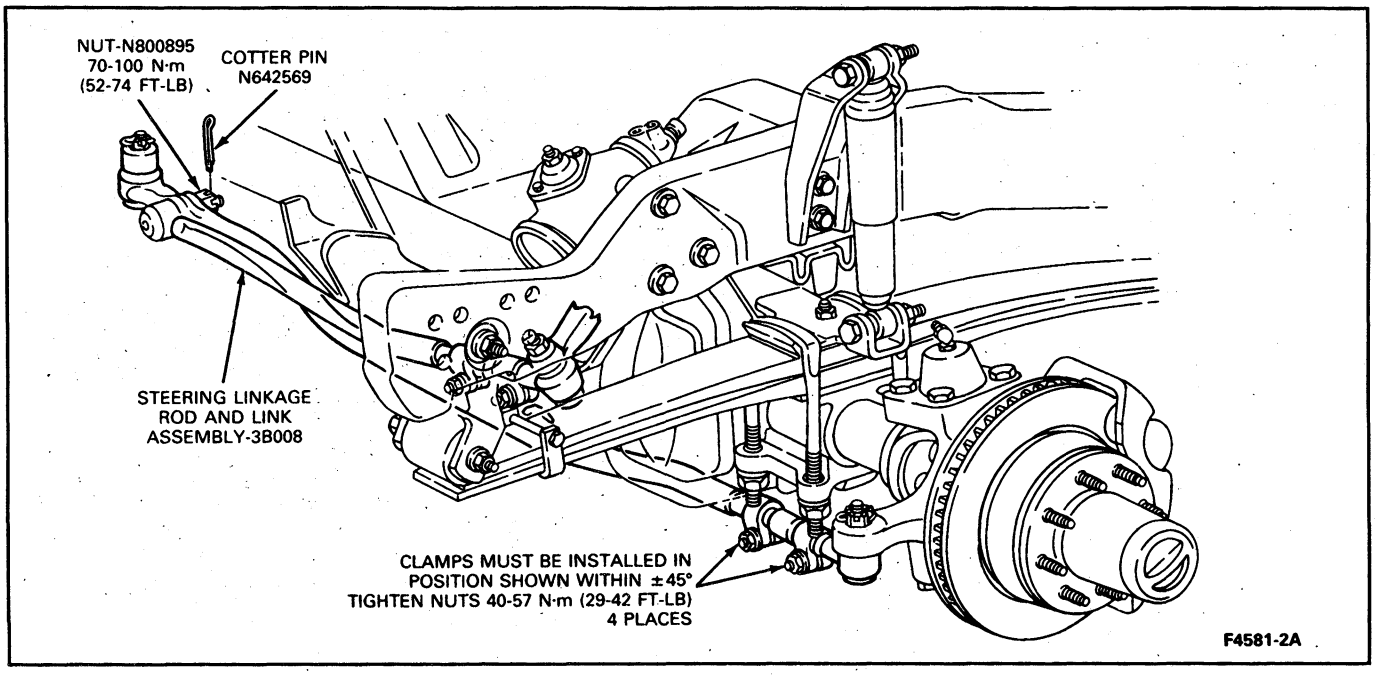


FIG. 4 Steering Linkage—F-350 (4x4) Monobeam Axle

2. Using the Tie Rod End Remover TOOL-3290-D or equivalent, remove the drag link ball studs from the right hand spindle and the Pitman arm. Remove the tie rod ball studs from the left hand spindle and the drag link.
3. When installing new drag link or tie rod end(s) or adjustment sleeve(s), turn the parts into the adjustment sleeve about the same distance used for the old assembly. Equalize the thread engagement of the short and long rod ends in the adjustment sleeve. This will provide an approximate toe-in setting.

Installation

1. Position the drag link ball studs into the right hand spindle and the Pitman arm. Position the tie rod ball studs into the left hand spindle and the drag link.

NOTE: For installation of components with rubberized ball sockets, be sure that the wheels and Pitman Arm are in the straight ahead position so that the rubber in the rubber ball sockets has no preload in that position. Installation of the linkage in other than the straight ahead position could cause the vehicle to drift toward the installed position.

2. Seat the studs into the tapered hole before tightening the nuts to avoid wrap up of the rubber during tightening. Tighten the nuts to specifications.
3. Install new cotter pins.
4. Check toe-in and set toe-in as described in Section 14-01, GENERAL SUSPENSION SERVICE.
5. After checking or adjusting toe-in, center the adjustment sleeve clamps between the locating nibs and position the clamps as shown in Figs. 1, 2, 3, and 7 to prevent clamp contact with surrounding components. Tighten the nuts to 40-57 N·m (29-41 ft-lbs). After installing a tie rod or drag link, make sure the tie rod adjustment sleeves are correctly positioned. For the correct tie-rod adjustment sleeve position refer to Figs. 1 through 7.

Pitman Arm

Replace the Pitman arm if the Pitman arm is bent. Do not attempt to straighten the Pitman arm.

Removal

1. Remove the cotter pin and nut from the drag link ball stud at the Pitman arm.
2. Disconnect the drag link ball stud from the Pitman arm using Tie Rod End Remover, TOOL-3290-D or equivalent (Fig. 8).
3. Remove the Pitman arm attaching nut and washer.
4. Remove the Pitman arm from the steering gear sector shaft using Tool T64P-3590-F (Fig. 9). Remove the tool from the Pitman arm.

Installation

1. Install the new Pitman arm assembly on the sector shaft with wheels in straight ahead position. Install the Pitman arm attaching washer and nut. Tighten the nut to specifications.
2. Install the drag link ball stud on the Pitman arm. Tighten the nut to 68-101 N·m (50-75 ft-lbs) and install the cotter pin.

Drag Link

Refer to Figs. 1, 2, 3, 5 and 7.

Replace the drag link if the ball stud is loose, or the drag link is bent. Do not attempt to straighten a drag link.

Removal

1. Raise the vehicle on a hoist with the wheels in the straight ahead position. Refer to Section 50-04, Hoisting and Jacking in the Light-Medium-Heavy, Pre-Delivery manual.

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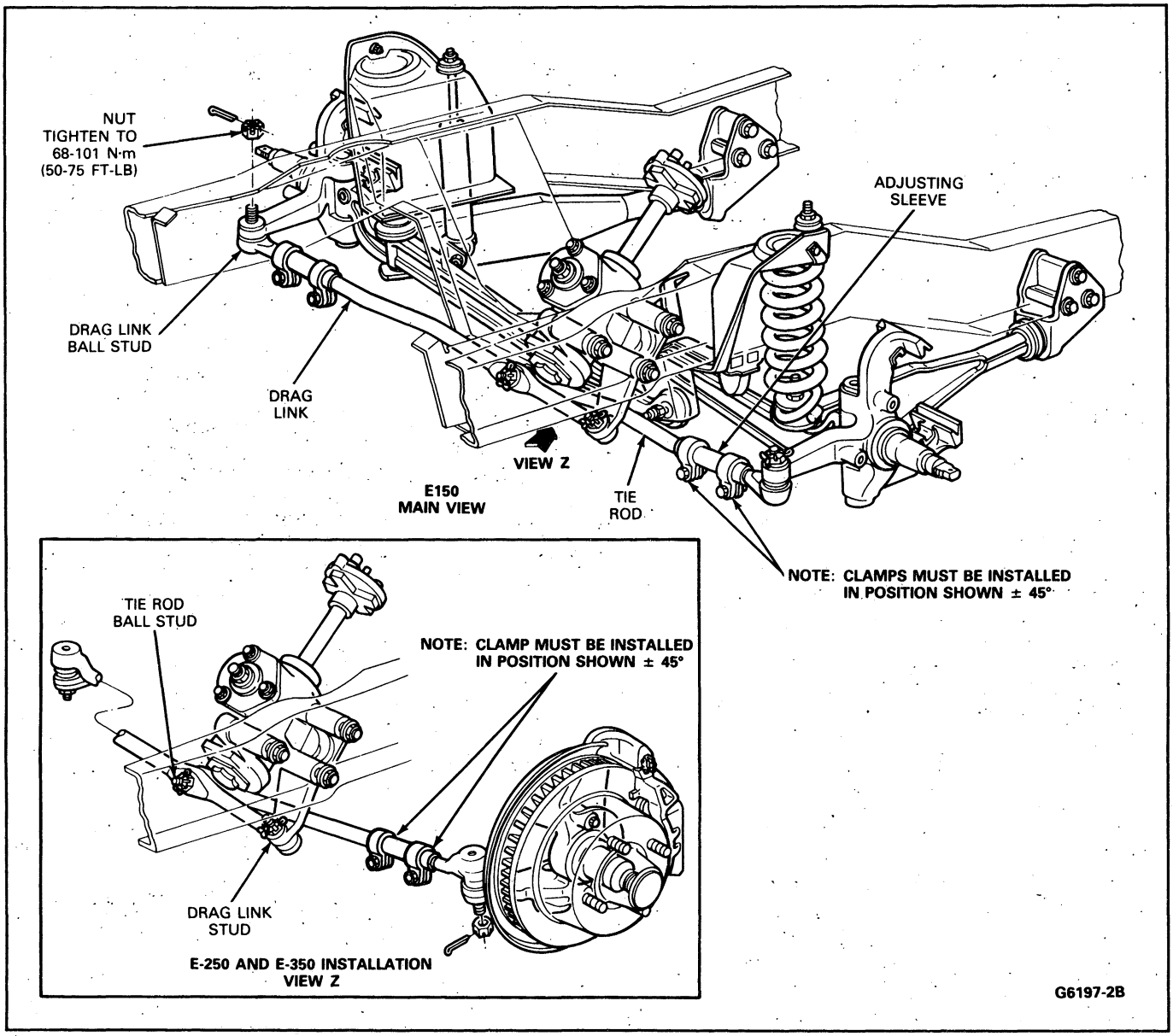


FIG. 5 Steering Linkage—E-150 Through E-350

2. Remove the cotter pins and nuts from the ball stud at the Pitman arm and steering tie rod. Remove the ball studs from the linkage using TOOL-3290-D, Tie Rod End Remover or equivalent as shown in Fig. 8.
3. Loosen the bolts on the adjuster clamp. Count the number of turns it takes to remove the drag link from the adjuster.

Installation

1. Install the drag link the same number of turns it took to remove it from the adjusting sleeve. Note the position of the clamps in Figures 1, 2, 3, and 7. Tighten the adjuster clamp nuts to 40-57 N·m (30-42 ft-lbs).
2. Position the drag link ball stud in the Pitman arm. Position the steering tie rod ball stud in the drag link. If the outer ball socket is rubberized, it is necessary to maintain the front wheels and steering wheel in the straight ahead position. Make sure the ball studs are seated in the taper to prevent rotation while tightening. Install nuts and tighten to specifications.
3. Install new cotter pins.
4. Check toe-in and adjust toe-in as described in Section 14-01. General Suspension Service, under Adjustments.

Steering Tie Rod

Refer to Figs. 1 through 7.

Replace the steering tie rod if the ball stud is loose or the rod is bent. Do not attempt to straighten a bent rod.

Removal

1. Raise the vehicle on a hoist with the wheels in the straight ahead position. Refer to Section 50-04, Hoisting and Jacking in the Light-Medium-Heavy, Pre-Delivery manual.
2. Remove the nut and cotter pin from the ball stud on the tie rod. Remove the ball stud from the drag

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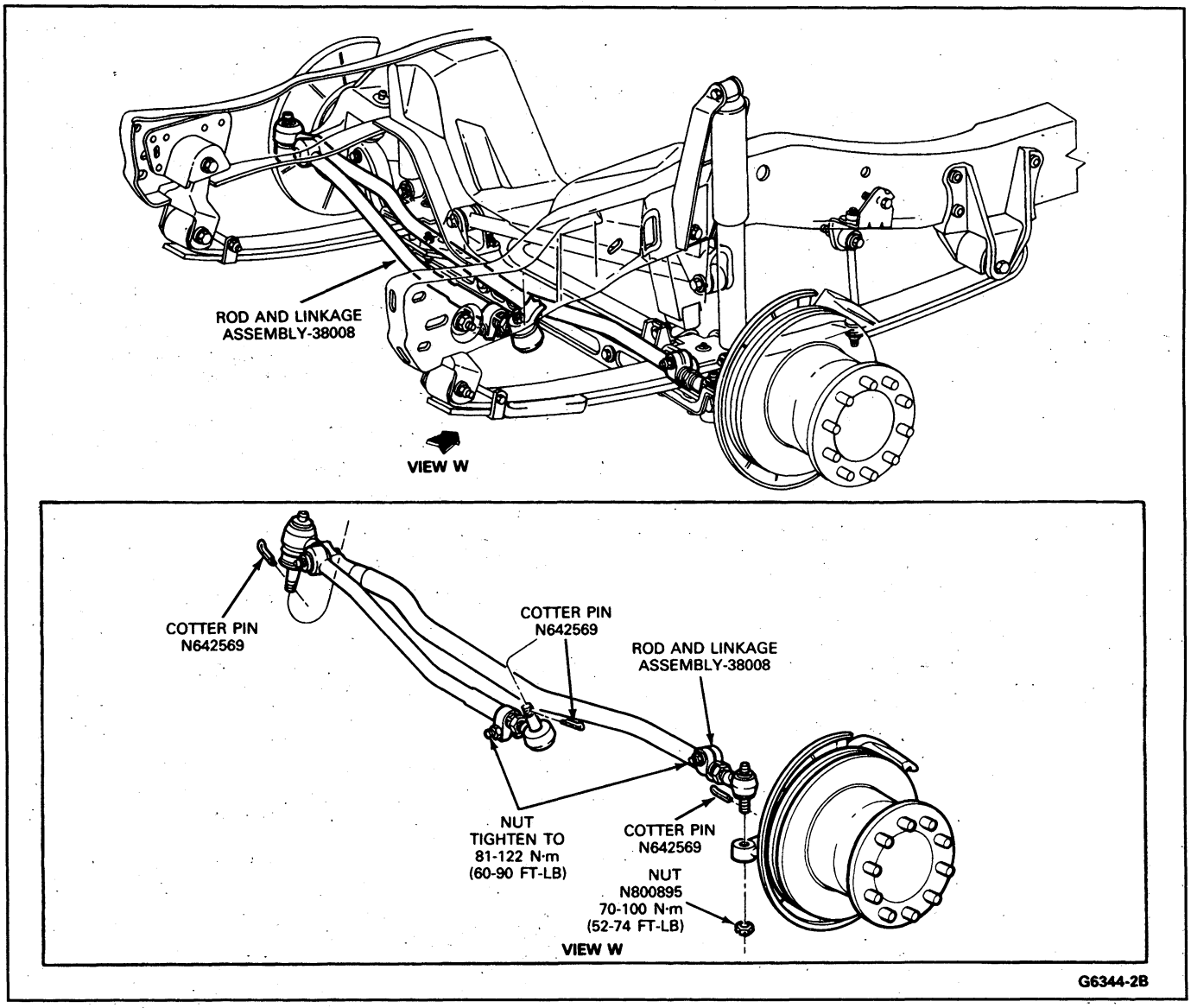


FIG. 6 Steering Linkage—F-Super Duty

link using TOOL-3290-D, Tie Rod End Remover, as shown in Fig. 8.

3. Loosen the bolts on the adjusting sleeve clamps. Count the number of turns it takes to remove the tie rod from the adjusting sleeve. Remove the tie rod.

Installation

1. Install the tie rod in the adjuster sleeve the same number of turns it took to remove it. Tighten the tie rod nuts to 40-57 N·m (30-42 ft-lbs).
2. Position the tie rod ball stud in the drag link. If the outer ball socket is a rubber design (does not have a grease fitting) it is necessary to maintain the front wheels and steering wheel in the straight ahead position. Make sure the ball stud is seated in the taper to prevent rotation while tightening. Install nut and tighten to specifications.
3. Install new cotter pins.
4. Check toe-in and adjust toe-in as described in Section 14-01, General Suspension Service, under Adjustments.

Tie Rod Adjusting Sleeve and Ball Stud

Rubberized Ball Socket Steering Linkage (R.B.S.)

Refer to Figs. 1, 2 and 5.

Replace the ball stud if it is loose or the tie rod is bent. Do not attempt to straighten a bent tie rod.

Removal

1. Raise the vehicle on a hoist with the wheels in the straight ahead position. Refer to Section 50-04, Hoisting and Jacking in the Light-Medium-Heavy, Pre-Delivery manual.
2. Remove the ball stud from the Pitman Arm using TOOL-3290-D, Tie Rod End Remover as shown in Fig. 8.
3. Loosen the nuts on the adjusting sleeve clamp. Remove the ball stud from adjuster or adjuster from tie rod. Count the number of turns it takes to remove the sleeve from the tie rod or ball stud from sleeve.

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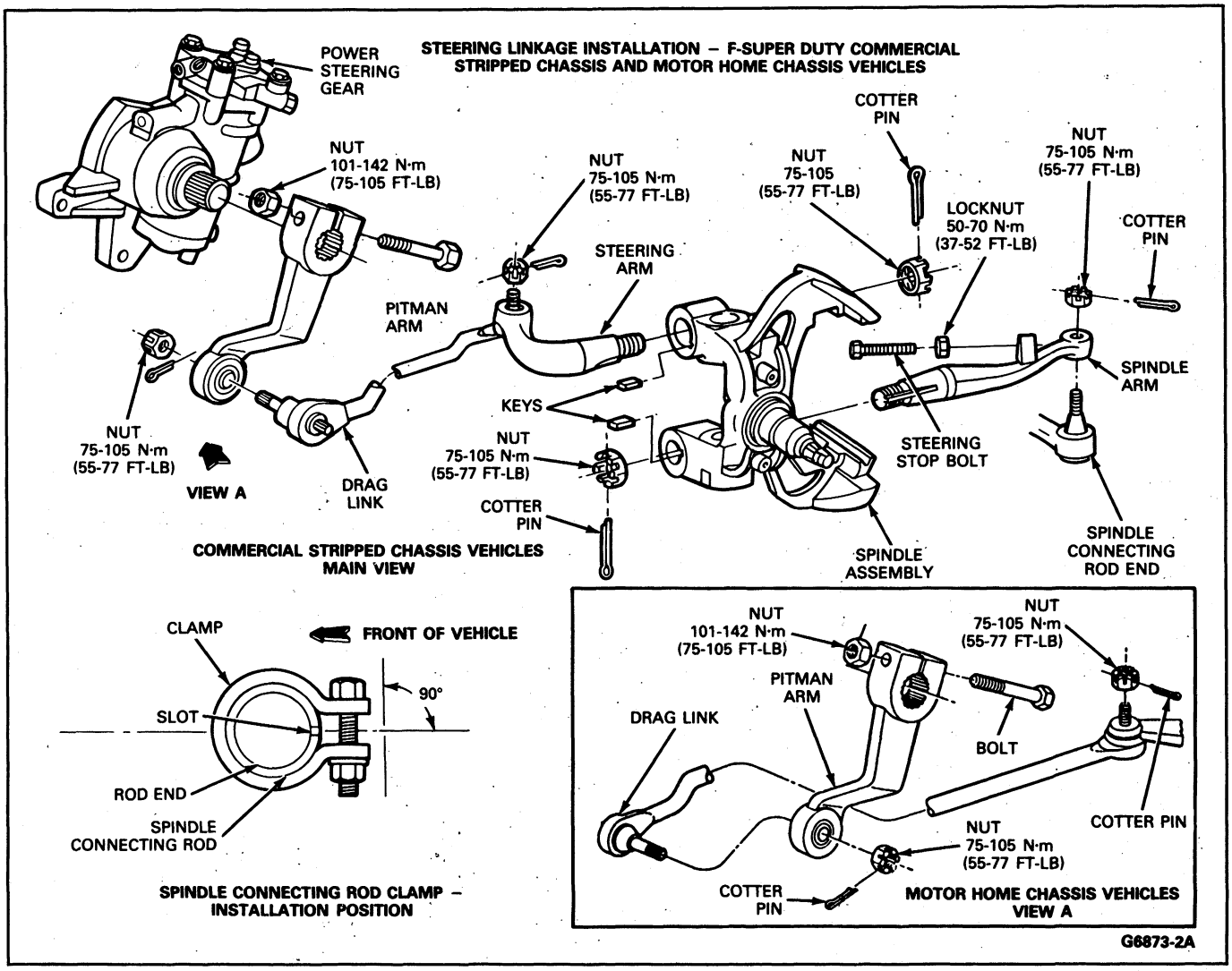


Fig. 7 Steering Linkage—F-Super Duty Commercial Stripped and Motor Home Chassis Vehicles.

Installation

1. Install the adjusting sleeve on the tie rod and/or the ball stud in the sleeve the same number of turns it took to remove it. Tighten nuts to 40-57 N·m (30-42 ft-lbs). Make sure the adjuster clamps are in the correct position as shown in Figs. 1, 2, 3, and 7.
2. Install the ball stud in the spindle arm. Maintain the front wheels and steering wheel in the straight ahead position. If the outer end is being replaced with a rubber ball socket design (does not have a grease fitting), it is necessary to make sure the ball stud is seated in the taper to prevent it from rotating while turning. Install nut and tighten to specifications. Install new cotter pins.
3. Install the drag link and steering tie rod as described in this Section.
4. Check toe-in and set toe-in as described in Section 14-01, General Suspension Service, under Adjustments.

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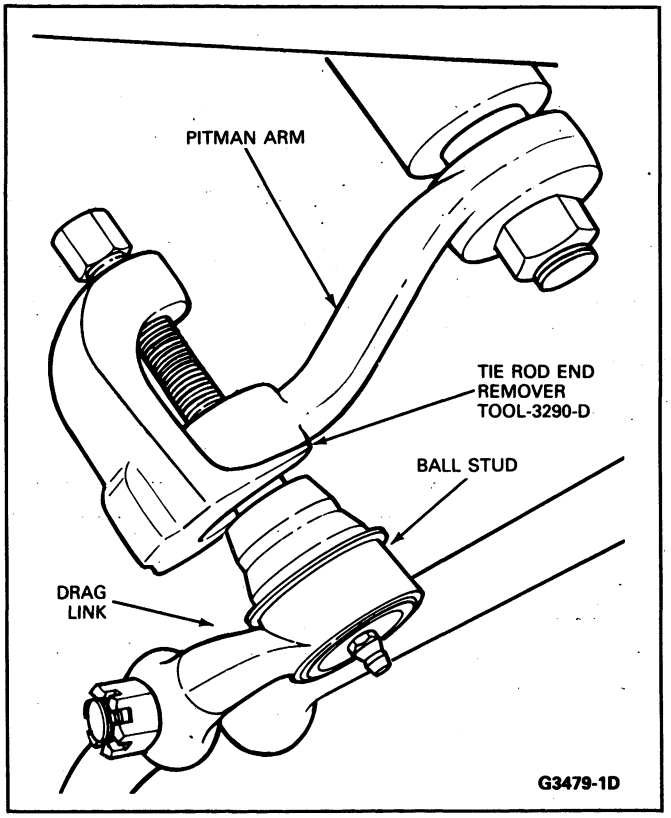


FIG. 8 Ball Stud Removal

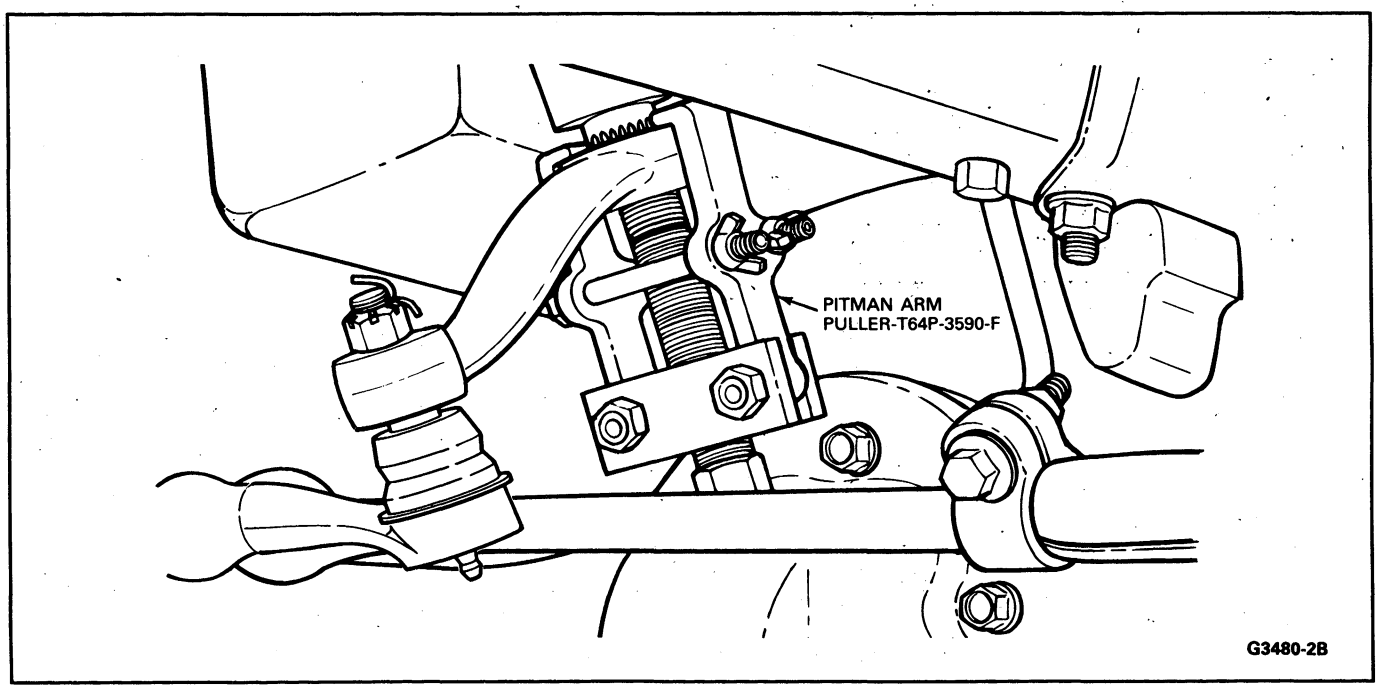


FIG. 9 Pitman Arm Removal

SPECIFICATIONS

Refer to Section 13-01, General Steering Service, for Specifications not listed here.

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SPECIAL SERVICE TOOLS

Number	Description	Application
D79P-3283-A	Tie Rod Adjustment Tool	Universal
TOOL-3290-D	Tie Rod End Remover	Universal
T75T-3527-A	Sector Bushing Tool	E-150 — E-350 — Bushing Removal and Replacement
T64P-3590-F	Pitman Arm Puller	Universal
T67L-3600-A	Steering Wheel Puller	Universal

CF3018-2D

TORQUE SPECIFICATIONS — F-150 — F-SUPER DUTY, E-150 — E-350 VEHICLES

Description	Torque	
	N·m	Ft-Lbs
Drag Link to Connecting Rod Ball Stud Nut	68-101	50-75
Drag Link to Pitman Arm Ball Stud Nut	68-101	50-75
Pitman Arm to Steering Gear Nut	230-310	170-230
Adjusting Sleeve Nuts	40-57	30-42
Adjusting Sleeve Nuts (F-Super Duty)	81-122	60-90
Tie Rod to Spindle Ball Stud Nut	68-101	50-75

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TORQUE SPECIFICATIONS F-SUPER DUTY COMMERCIAL STRIPPED CHASSIS AND MOTOR HOME CHASSIS VEHICLES

Description	Torque	
	N·m	Ft-Lb
Drag Link to Steering Arm — Castellated Nut	75-105	55-77
Drag Link to Pitman Arm — Castellated Nut	75-105	55-77
Pitman Arm Retaining Bolt and Nut	101-142	75-105
Steering Connecting Rod Ends to Spindle Arms — Castellated Nut	75-105	55-77
Steering Connecting Rod End Clamp — Bolt and Nut	42-56	31-42

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SECTION 13-41 Integral Power Steering Gear—Ford

SUBJECT	PAGE
ADJUSTMENTS	
Meshload	13-41-5
Adjustment In Vehicle	13-41-5
Rotary Valve Centering Check	13-41-5
DESCRIPTION AND OPERATION	13-41-1
DIAGNOSIS AND TESTING	13-41-2
DISASSEMBLY AND ASSEMBLY	
Piston	13-41-11
Steering Gear	13-41-6
DISASSEMBLY AND ASSEMBLY (Cont'd)	
Steering Gear Housing	13-41-8
Valve Housing	13-41-9
Worm and Valve Sleeve	13-41-10
REMOVAL AND INSTALLATION	
Steering Gear	13-41-5
SPECIFICATIONS	13-41-13
VEHICLE APPLICATION	13-41-1

VEHICLE APPLICATION

Applies to all F-150-350, E-150-350, Bronco and F-Super Duty Vehicles.

DESCRIPTION AND OPERATION

The steering unit is an integral piston and recirculating ball nut, and a hydraulically assisted power steering gear with a rotary type control valve. The gear contains a torsion bar that provides feedback between the steering wheel and the road wheels. The system furnishes power to reduce turning effort at the steering wheel. It also reduces road shock and vibrations.

The power steering unit includes a worm and one-piece rack piston. The piston rack meshes to the gear teeth on the steering sector shaft. The unit also includes a rotary style hydraulic valve consisting of input shaft, control valve sleeve and torsion bar. The valve sleeve is pinned to the worm and the input shaft is connected to the worm through the torsion bar. Hydraulic action is generated by relative rotary motion between input shaft and worm/sleeve assembly.

The power steering gear is designed with the one-piece rack piston; worm and sector shaft in one housing and the rotary valve assembly in an attached housing (Fig. 1). This makes possible internal fluid passages between valve and power cylinder, eliminating all external lines and hoses, except the pressure and return hoses between the pump and gear assembly.

The piston cylinder is an integral part of the gear housing. The piston is double acting, in that fluid pressure may be applied to either side of the piston.

The control valve is a unique rotary design that uses relative rotational motion of the input shaft and valve sleeve to direct and throttle fluid flow. In a neutral (straight ahead) position, where no power assist is required, the valve input shaft and sleeve are held in a central position by the torsion bar. The fluid flows from the inlet port through the valve to the outlet port and back to the pump. No area of the steering gear is under high pressure in this position. The valve and housing cylinder are always full of power steering fluid, which dampens road shock that otherwise would be transmitted to the driver through the steering wheel.

The valve input shaft is attached on one end to the steering column and steering wheel. The other end is connected to the worm through the torsion bar

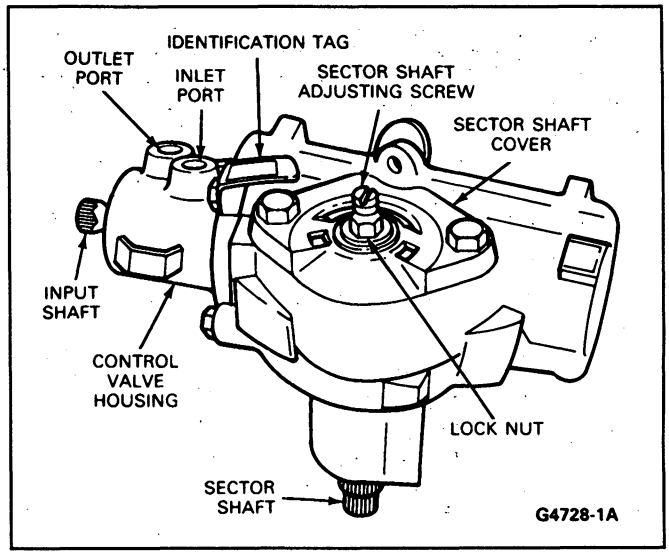


FIG. 1 Ford Integral Power Steering Gear F-150—F-350, E-150—E-350, Bronco and F-Super Duty

providing the link to the road wheel side of the steering system. As a steering maneuver is initiated, rotational force, applied through the steering wheel/column to the input shaft, is transmitted to the worm where it meets the resisting forces of the road wheels. When the steering forces are great enough, rotational deflection (twisting) of the torsion bar occurs. This deflection changes the relative position of the input shaft and control valve sleeve causing throttling of the hydraulic flow and directing high pressure fluid to the appropriate end of the piston in the gear housing.

The difference in pressure forces on the piston helps move the sector shaft, thus assisting in the turning effort. The oil in the opposite end of the gear housing is forced out through the return outlet of the control valve and back to the pump reservoir. With higher steering efforts, increased valve displacement will give the driver proportionately higher assisting pressure. The driver will have a smooth hydraulic assist at all times.

When the driver stops applying steering effort, the valve sleeve and input shaft are returned to a centered position by the torsion bar. When this occurs, pressure is equalized on both sides of the piston. The steering

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geometry will tend to return the front wheels to the straight-ahead position.

NOTE: A hissing noise is a normal characteristic of rotary valve steering gear and in no way affects steering. A replacement valve will also exhibit slight noise; so, it is not always a cure for the complaint. Any metal-to-metal contacts at the flexible steering shaft coupling (due to column misalignment) will transmit severe valve hissing noise into the passenger compartment and should be corrected.

The only service that can be performed on the control valve assembly is the replacement of the four teflon seals on the valve sleeve and replacement of the control valve housing.

DIAGNOSIS AND TESTING

Refer to the following guides for aid in diagnosing steering gear conditions. For other related diagnosis and testing procedures, refer to Section 13-01, General Steering Service.

STEERING GEAR CONDITIONS

COMPLAINT	POSSIBLE CAUSE	RESOLUTION
Feedback (Rattle, Chuckle, Knocking Noise in Steering Gear) Feedback is a condition that is noticed when a truck is driven over rough pavement and this roughness is felt in the steering wheel by the driver. In addition, if the gear is not adjusted properly, excessive rattle, knocking and/or chuckle noises can be heard inside the truck.	1. Deteriorated Shock Absorbers. 2. Loose flex coupling bolt. 3. Gear loose on frame. 4. Steering linkage ball-joints loose/worn. 5. Insufficient meshload. 6. Loose worm race nut. 7. Insufficient worm thrust bearing preload. 8. Damaged/omitted sector shaft bearing (gear might also exhibit external leakage from sector seals).	1. Replace Shock Absorbers. 2. Tighten bolt. 3. Tighten mounting bolts (3) to specification. 4. Replace appropriate tie rod end assemblies. 5. Set meshload to specification. 6. Tighten nut to specification. 7. Replace valve assembly. 8. Replace gear housing.
Hissing Sound There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. There is no relationship between this noise and the performance of the steering gear.	1. "Hiss" may be expected when the steering wheel is at the end of travel or when turning it at standstill.	1. Hiss is a normal characteristic of rotary valve steering. Do not replace the input shaft and valve assembly unless the hiss is extremely objectionable. A replacement valve will also exhibit a slight noise and is not usually a cure for the condition. Investigate for a grounded column or a loose boot at the dash panel. Any metal to metal contacts will transmit valve hiss into the passenger compartment through the steering column. Verify clearance between flexible coupling components. Be sure steering column shaft and gear are aligned so flexible coupling rotates in a flat plane and is not distorted as shaft rotates.

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STEERING GEAR CONDITIONS (Cont'd.)

COMPLAINT	POSSIBLE SOURCE	RESOLUTION
Front End Wander Front end wander is a condition that is noticed when the truck is driven in a straight ahead position with the wheel held in a firm position, but the truck wanders to either the right or left side. Front end alignment should be checked before any gear service is made.	**NOTE: Front end alignment and tire pressures should be checked before any gear service is performed.**	
	1. Steering linkage ball joints loose/ worn.	1. Replace appropriate tie rod end assemblies. Refer to the appropriate section in the Steering group.
	2. Loose flex coupling bolt.	2. Tighten bolt.
	3. Steering wheel, column or flex coupling binding or misalignment.	3. Service as required.
	4. Gear loose on frame.	4. Tighten mounting bolts (3) to specification.
	5. Incorrect meshload.	5. Set meshload to specification.
	6. Loose worm/piston race nut.	6. Tighten nut to specification.
	7. Insufficient worm thrust bearing preload.	7. Replace valve assembly.
	8. Damaged sector shaft bearing (gear might also exhibit external leakage from sector seals).	8. Replace gear housing assembly.
	9. Center lash.	9. Improper fit of worm to piston. Replace valve assembly. **(Be certain to check meshload prior to replacing valve for center lash.)**
Heavy Steering Efforts, Poor Assist A heavy effort and poor assist condition is recognized by the driver while turning corners and especially while parking. A road test can verify the condition.	Poor Assist — both directions	
	1. Low Steering system fluid fill.	1. Add steering fluid to proper level.
	2. Engine idle too low.	2. Set engine idle to specification.
	3. Low power steering pump belt tension.	3. Set belt tension to specification.
	4. Pump flow/relief pressure not to specification.	4. Test pump, and service as necessary.
	5. External leakage giving low fluid level.	5. See diagnosis guide for external leakage.
	6. Piston plastic O-ring cut or twisted.	6. Replace piston plastic O-ring.
	7. Loose/mission rubber backup piston O-ring.	7. Replace/install rubber backup piston O-ring.

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STEERING GEAR CONDITIONS (Cont'd.)

COMPLAINT	POSSIBLE CAUSE	RESOLUTION
Heavy Steering Efforts, Poor Assist (Cont'd.)	8. Valve/gear housing oil passages blocked.	8. Replace gear housing or valve housing as required.
	9. Leakage past piston end cap.	9. Tighten piston end cap to specification.
	10. Porosity in piston bore (housing casting).	10. Replace gear housing.
	11. Porosity in piston.	11. Replace valve assembly.
	12. Valve plastic O-ring(s) damaged.	12. Replace valve plastic O-rings.
	13. Worm seal ring missing or damaged.	13. Replace valve assembly.
External Leakage One of the most common conditions causing repeat repairs is fluid leaks. Make sure you clean the steering gear first before any steering gear external leakage checks are performed.	1. Loose hose fittings.	1. Tighten hose fittings to specification.
	2. Missing/damaged hose fitting tube seats.	2. Install/replace tube seats.
	3. Leak from input shaft seal.	3. Replace input shaft seal. Check shaft for damage. Check housing bore for porosity or damage.
	4. Leak at valve mounting face.	4. Check bolts for proper torque. Replace valve housing O-ring(s).
	5. Leak at sector adjuster screw locknut.	5. Replace locknut (check torque).
	6. Leak at sector shaft seal.	6. Replace sector seals and examine sector shaft for pitting or corrosion. Replace sector shaft if necessary. Check housing seal bore for porosity or damage. Replace housing if necessary.
	7. Leak from gear housing.	7. Replace gear housing.
	8. Leak at sector cover face.	8. Check bolt torques. Check O-ring seal.
Poor Returnability — Sticky Feeling Poor returnability is a condition that is noticed when the vehicle is in a turn and returns to center with effort from the driver. In addition, when the driver returns the steering wheel to center, it may have a sticky or catchy feel.	1. Wheel alignment not to specification.	1. Reset wheel alignment.
	2. Tire pressure too high.	2. Adjust tire pressure.
	3. Binding steering column.	3. Service steering column as required.
	4. Steering column not properly aligned — flex coupling distorted.	4. Align steering column.
	5. Meshload set too tight.	5. Reset meshload to specification.
	6. End lash adjusting screw not properly staked to sector.	6. Replace sector assembly.
	7. Damaged input shaft bearing.	7. Replace valve assembly.
	8. Binding in valve assembly.	8. Replace valve assembly.

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ADJUSTMENTS

Meshload

During the vehicle breaking-in period, some factory adjustments may change. These changes in adjustment will not necessarily affect operation of the steering gear assembly. If excessive steering lash is encountered, then a meshload adjustment may be required.

Adjustment In Vehicle

Adjust total over center position load, to eliminate excessive lash between the sector and rack teeth as follows. See meshload specifications at the end of this Section for checking and setting values. This is the only adjustment required.

1. Disconnect the Pitman arm from the sector shaft using Tool T64P-3590-F, Pitman Arm Puller.
2. Disconnect the fluid return line at the reservoir and cap the reservoir return line pipe.
3. Place the end of the return line in a clean container and turn the steering wheel from left to right several times to discharge the fluid from the gear. Discard the fluid.
4. Turn the steering wheel to 45 degrees from the right stop.
5. Attach an in-lb torque wrench to the steering wheel nut and determine the torque required to rotate the shaft slowly approximately one-eighth turn toward center from the 45 degree position.
6. Turn the steering gear back to center and determine the torque required to rotate the shaft back and forth across the center position (± 90°). See the end of this section for checking and resetting specifications. If reset is required, loosen the adjuster locknut and turn the sector shaft adjuster screw (Fig. 1) until the reading is the specified value greater than the torque at 45 degrees from the stop.

   Hold the sector shaft screw in place, and tighten the lock nut.
7. Re-check torque readings and replace the Pitman arm and steering wheel hub cover.
8. Connect the fluid return line to the reservoir and fill the reservoir to specification (Section 13-01, General Steering Service). Adjust belt tension, if necessary.

   Do not pry against the reservoir to obtain proper belt load. Pressure will deform the reservoir and cause it to leak.

Rotary Valve Centering Check

1. Install a 0-13,789 kPa (0-2000 psi) pressure-gauge (Tool D79L-33610-A, Power Steering Analyzer) in the pressure line between the power steering pump outlet port (Fig. 1) and the integral steering gear inlet port. Be sure that the valve on the gauge is fully open.
2. Check the fluid level in the reservoir and add Premium Power Steering Fluid - E6AZ-19582-AA (ESW-M2C33-F) or equivalent, if necessary.
3. Start the engine and turn the steering wheel from stop-to-stop to bring the steering lubricant to normal operating temperature. Turn off the engine and re-check the fluid level. Add Premium Power Steering Fluid - E6AZ-19582-AA (ESW-M2C33-F) or equivalent, if necessary.
4. With the engine running at approximately 1000 rpm and the steering wheel centered, attach an in-lb torque wrench to the steering wheel nut. Apply sufficient torque in each direction to get a gauge reading of 1723 kPa (250 psi).
5. The torque wrench readings should be the same in both directions at 1723 kPa (250 psi). If the difference between the readings exceeds 0.68 N·m (6 in-lbs), remove the steering gear and replace the shaft and control assembly.
6. When performing the valve spool centering check outside the vehicle, use the procedures described above, except take the torque and pressure readings at the right and left stops instead of either side of center.

   NOTE: A hissing noise is a normal characteristic of rotary valve steering gears and in no way effects steering. Do not replace the shaft and control assembly unless the hiss is EXTREMELY objectionable. A replacement valve will also exhibit slight noise, and is not always a cure for the complaint. Any metal-to-metal contacts, such as column grounding, coupling grounding, or sheet metal to steering components will transmit valve hiss noise into the passenger compartment.

   The only service that can be performed on the new valve assembly is the replacement of the four valve sleeve O-rings on the valve sleeve and replacement of the control valve housing.

REMOVAL AND INSTALLATION

Steering Gear

Refer to Figs. 2 and 3.

Removal

Remove the steering gear as follows:

1. Disconnect the pressure and return lines from the steering gear. Plug the lines and the ports in the gear to prevent entry of dirt.
2. If equipped, remove the splash shield from the flex coupling. Disconnect the flex coupling at the steering gear by removing the bolt.
3. Raise the vehicle and remove the Pitman arm attaching nut, and washer.
4. Remove the Pitman arm from the sector shaft using Tool T64P-3590-F, Pitman arm remover. Remove the tool from the Pitman arm. **Do not damage the seals.**
5. Support the steering gear, and remove the steering gear attaching bolts.
6. Work the steering gear free of the flex coupling. Remove the steering gear from the vehicle.

Installation

1. If equipped, install the splash shield onto the steering gear lugs.
2. Slide the flex coupling into place on the steering shaft assembly. Turn the steering wheel so the spokes are in the horizontal position.
3. Center the steering gear input shaft with the indexing flat facing down.

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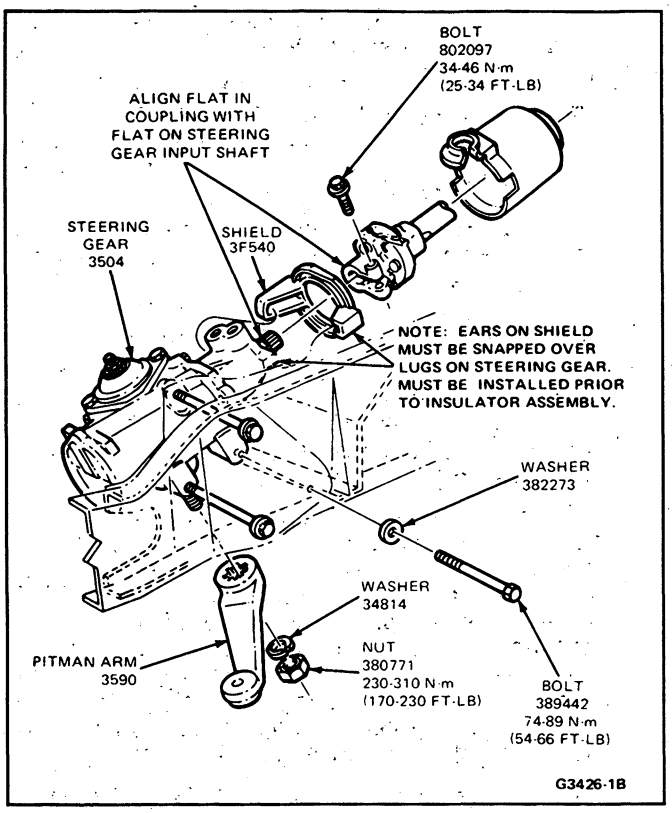


FIG. 2 Steering Gear Installation—F-150—F-350, Bronco and F-Super Duty

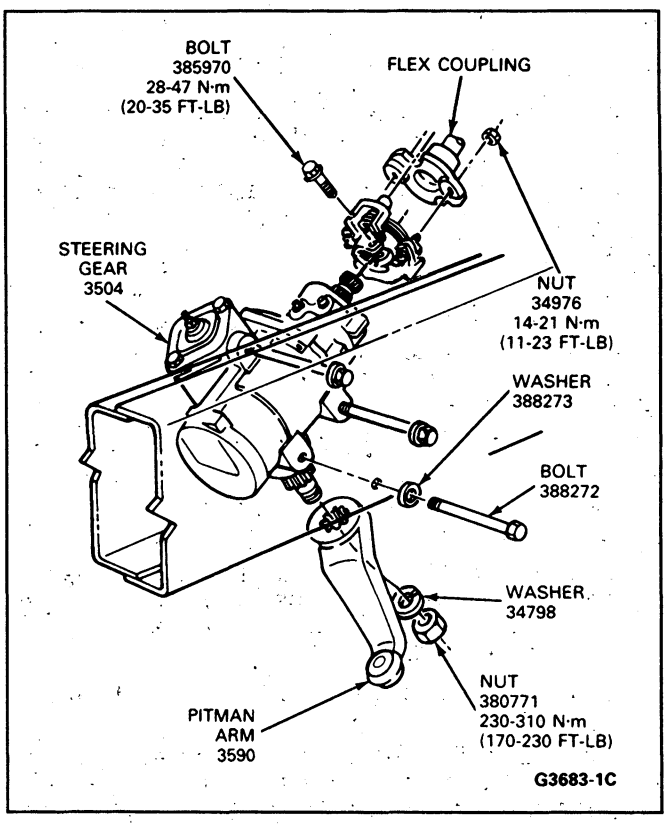


FIG. 3 Steering Gear Installation—E-150—E-350

4. Slide the steering gear input shaft into the flex coupling and into place on the frame side rail. Install the flex coupling attaching bolt and tighten to 34-46 N·m (25-34 ft-lbs) on F-150—F-350 and Bronco and to 28-47 N·m (20-35 ft-lbs) on E-150—E-350. Install the gear to frame attaching bolts and tighten to 74-89 N·m (54-66 ft-lbs).
5. Be sure the wheels are in the straight ahead position, then install the Pitman arm on the sector shaft. Install the Pitman arm attaching washer and nut. Tighten nut to 230-310 N·m (170-230 ft-lbs).
6. Connect and tighten the pressure and the return lines to the steering gear.
7. Snap the Flex-coupling shield over the hose fitting and the splash shield.
8. Disconnect the coil wire. Fill the reservoir to specification (Section 13-01, General Steering Service). Turn on the ignition and turn the steering wheel from left to right to distribute the fluid.
9. Re-check fluid level and add Premium Power Steering Fluid - E6AZ-19582-AA (ESW-M2C33-F) or equivalent, if necessary. Connect the coil wire, start the engine and turn the steering wheel from side to side. Inspect for fluid leaks.

DISASSEMBLY AND ASSEMBLY

Take the following precautions when servicing the steering gear:

1. Use a clean workbench and tools.
2. Thoroughly clean the exterior of the gear with solvent and drain off excess hydraulic fluid, if necessary.
3. Handle all parts carefully to avoid nicks, burrs, scratches and dirt.
4. Do not use solvent on seals.

Steering Gear

Disassembly

1. Hold the steering gear upside down over a drain pan and cycle the input shaft several times to drain the fluid from the gear.
2. Secure the gear in a soft-jawed vise.
3. Remove the nut from the sector shaft adjusting screw (Fig. 1).
4. Turn the input shaft to either stop, then turn it back two turns to center the gear.

   NOTE: The indexing flat on the input shaft spline should be facing downward.
5. Remove the sector shaft cover attaching bolts.
6. Tap the lower end of the sector shaft with a soft-hammer to loosen it, and lift the cover and shaft from the housing **as an assembly.** Discard the O-ring.
7. Turn the sector shaft cover counterclockwise and remove it from the sector shaft adjuster screw (hold screw with screwdriver if necessary to prevent turning).
8. Remove the valve housing attaching bolts and identification tag. Lift the valve housing off the steering gear housing. Remove the valve housing and control valve gasket. Discard the gasket.

   NOTE: If valve housing or the valve sleeve seals are to be replaced, proceed to Step 11. If sector shaft seals are to be replaced go to steering gear

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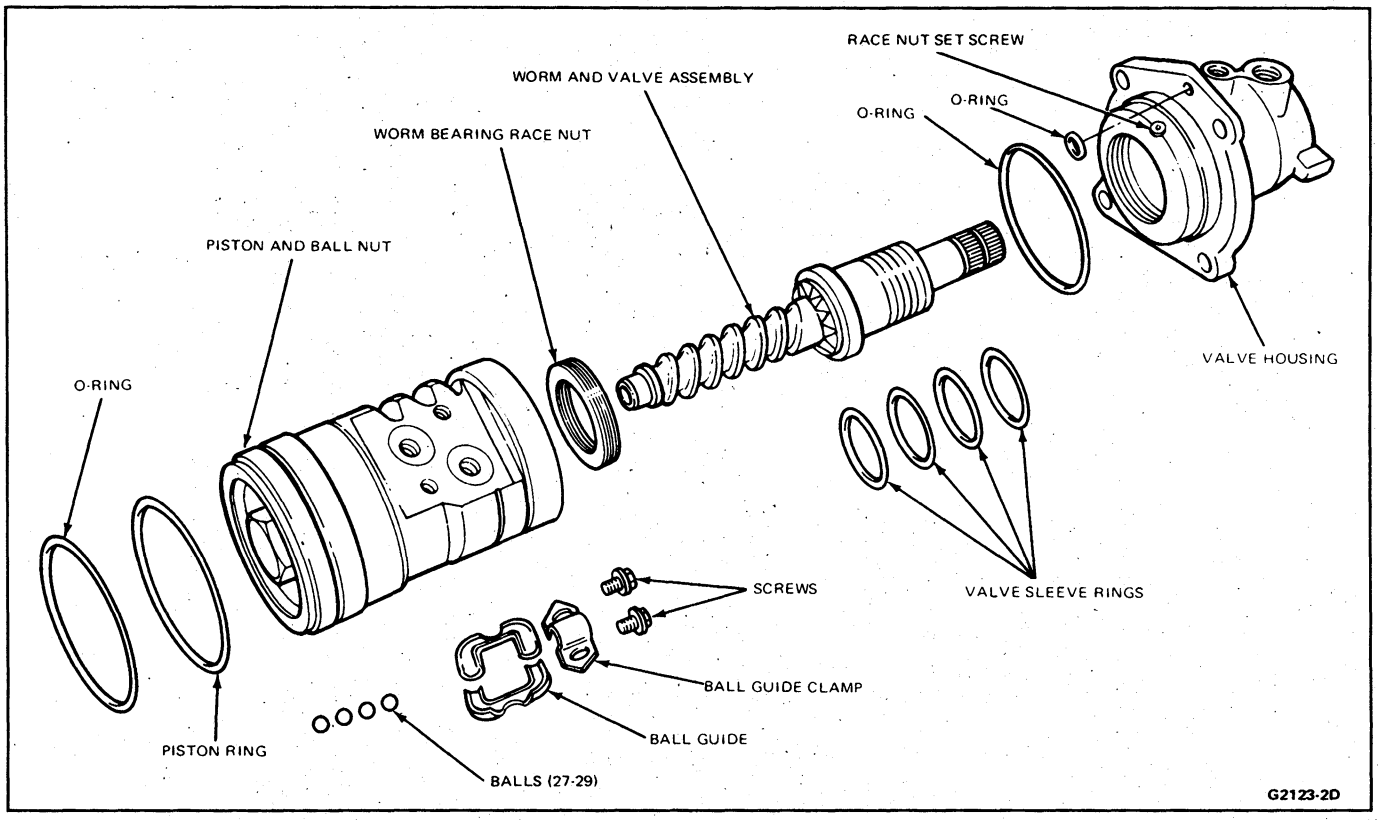


FIG. 4 Ball Nut and Housing Disassembled—Rotary Valve Type

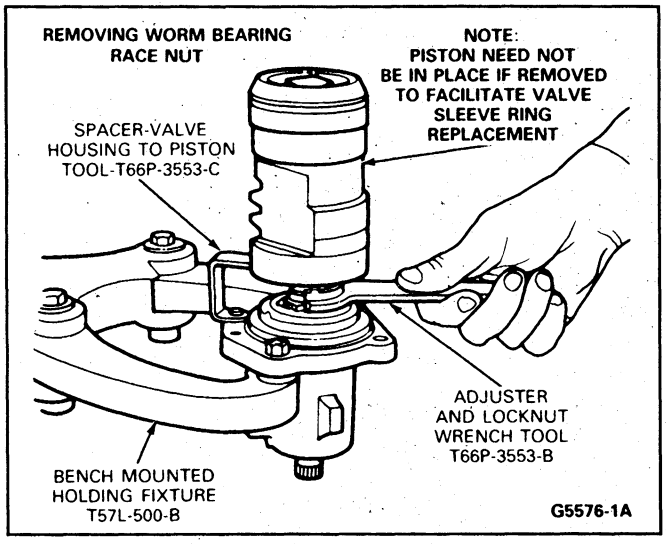


FIG. 5 Removing or Installing Worm Bearing Race Nut

housing section. Balls need only to be removed if valve sleeve rings are to be replaced.

9. With the piston held so that the ball guide faces up, remove the ball guide clamp screws and ball guide clamp. With a finger over the opening in the ball guide, turn the piston so that the ball guide faces down over a clean container. Let the guide tubes drop into the container (Fig. 4).

10. Rotate the input shaft from stop to stop until all balls fall from the piston into the container. The valve assembly can then be removed from the piston. **Inspect the piston bore to insure all balls have been removed.**

11. Install the valve body assembly in the bench mounted holding fixture, Tool T57L-500-B, and loosen the Allen head race nut screw from the valve housing. Remove the worm bearing race nut using Tools T66P-3553-B, Adjuster and Lock Nut Wrench, and T66P-3553-C, Valve Housing to Piston Spacer, as shown in Fig. 5.

12. Carefully slide the input shaft, worm and valve assembly out of the valve housing.

Assembly

1. Mount the valve housing in the bench mounted holding fixture, Tool T57L-500-B, with the flanged end up.

2. Apply a light coat of gear lubricant, Standard Transmission Lubricant (SAE 80W), D8DZ-19C547-A (ESP-M2C83-C) or equivalent to the Teflon rings on the valve sleeve.

3. Carefully install the worm shaft and valve in the housing.

4. Install the worm bearing race nut in the housing and tighten to 75-122 N·m (55-90 ft-lbs)

5. Install the Allen head race nut set screw through the valve housing and tighten to specification 1.7-2.8 N·m (15-25 in-lbs).

6. Place the power cylinder piston on the bench with the ball guide holes facing up. Insert the worm shaft into the piston so that the first groove is in line with the hole nearest the center of the piston (Fig. 6).

7. Place the ball guides in the piston. Turning the worm shaft counterclockwise as viewed from the input end of the shaft, place the same balls as removed in Step 9 of Steering Gear Disassembly in

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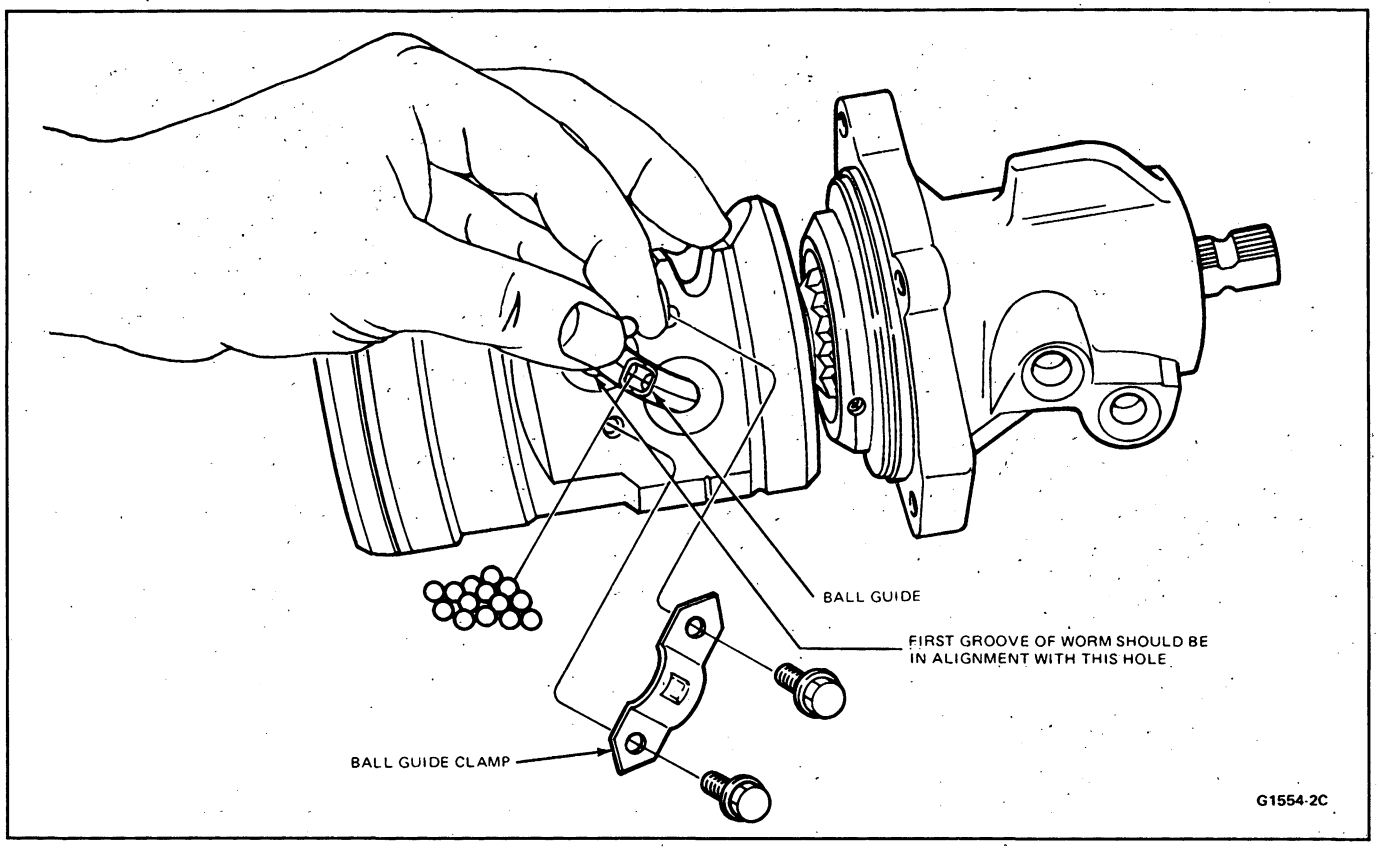


FIG. 6 Assembling Piston on Worm Shaft

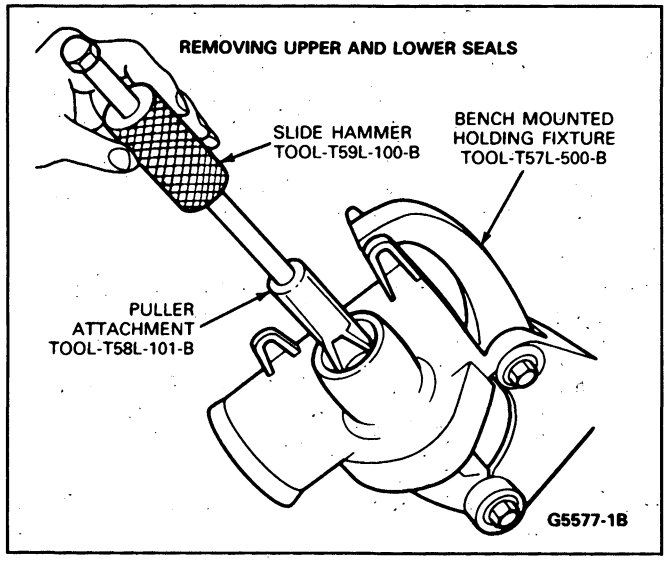


FIG. 7 Removing Upper and Lower Seals

the ball guide (Figure 6). A minimum of 27 balls is required. If all the balls have not been inserted upon reaching the left stop, rotate the input shaft in one direction then the other while inserting the remaining balls.

8. Secure the guides in the ball nut with the clamp (Fig. 4). Tighten screws to 4.8-7.9 N·m (42-70 in-lbs).
9. Apply petroleum jelly or equivalent to the Teflon seal on the piston.
10. Place a new control valve O-ring on the valve housing.
11. Slide the piston and valve into the gear housing being careful not to damage the piston ring.
12. Align the oil passage in the valve housing with the passage in the gear housing. Place a new O-ring onto the oil passage hole of the gear housing. Install identification tag onto the housing. Install **but do not tighten,** the attaching bolts. Identification tag is to be installed under upper right valve housing bolt (Fig. 1).
13. Rotate the ball nut so that the teeth are in the same plane as the sector teeth. Tighten the valve housing attaching bolts to 40-60 N·m (30-45 ft-lbs)
14. Position the sector shaft cover O-ring in the steering gear housing. Turn the input shaft to center the piston.
15. Apply petroleum jelly or equivalent to the sector shaft journal, and position the sector shaft and cover assembly in the gear housing. Install the sector shaft cover attaching bolts. Tighten the bolts to 75-94 N·m (55-70 ft-lbs).
16. Attach an in-lb torque wrench to the input shaft. Adjust meshload to specification. Refer to specifications at the end of this Section.

Steering Gear Housing

Disassembly

1. Remove the snap ring from the lower end of the housing.
2. Remove dust seal using tools puller attachment T58L-101-B, and slide hammer T59L-100-B or equivalent, (Fig. 7). Discard the seal.

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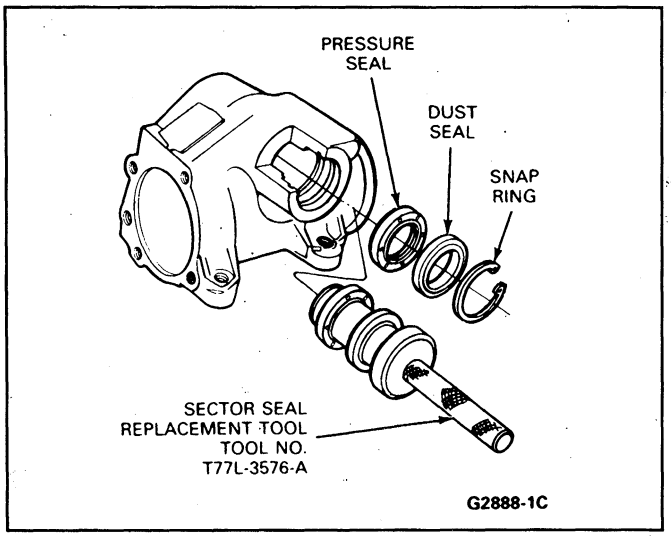


FIG. 8 Installing Sector Shafts Seals

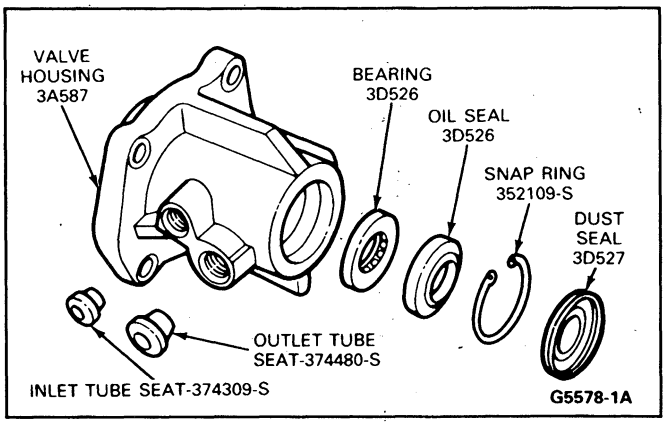


FIG. 9 Valve Housing Disassembled

3. Remove pressure seal in the same manner. Discard the seal.

Assembly

1. Lubricate the new pressure seal and new dust seal with clean Multi-Purpose Grease, DOAZ-19584-AA (ESR-M1C159-A) or equivalent.
2. Apply Multi-Purpose Grease, DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the sector shaft seal bore.
3. Place the dust seal on Sector Shaft Replacement Tool T77L-3576-A or equivalent, so the raised lip of the seal is towards the tool (Fig. 8).

   Place the pressure seal on the tool with lip away from the tool. The flat back side of the pressure seal should be against the flat side of the dust seal.
4. Insert the seal driver tool into the sector shaft bore and drive the tool until the seals clear the snap ring groove. Do not bottom seals against bearing. **The seal will not function properly when bottomed against the bearing.**
5. Install snap ring in the groove in the housing.
6. Apply a generous amount of Multi-Purpose Grease, DOAZ-19584-AA (ESR-M1C159-A) or equivalent grease to the areas between the seal lips.

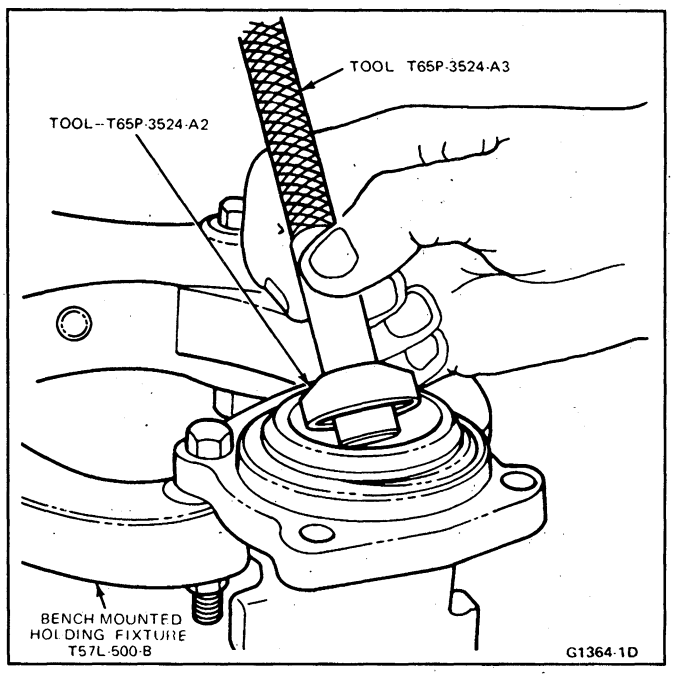


FIG. 10 Removing Bearing and Oil Seal

Valve Housing

Disassembly

1. Remove the dust seal (Fig. 9) from the rear of the valve housing using puller attachment T58L-101-B, and slide hammer T59L-100-B. Discard the seal.
2. Remove the snap ring from the valve housing.
3. Turn the bench mounted holding fixture to invert valve housing.
4. Insert Tools T65P-3524-A2 and T65P-3524-A3 from the Input Shaft Bearing/Seal Tool in the valve body assembly opposite the oil seal end and gently tap the bearing and seal out of the housing as shown in Fig. 10. Discard the seal. **Do not damage the housing when inserting and removing the tools.**
5. Remove the fluid inlet and outlet tube seats with Tube Seat Remover T74P-3504-L if they are damaged.

Assembly

1. Coat the fluid inlet and outlet tube seats with petroleum jelly or equivalent and install them in the housing with a Tube Seat Installer T74P-3504-M.
2. Coat the bearing and seal surface of the housing with petroleum jelly or equivalent.
3. Install the bearing with the metal side covering the rollers facing outward. Seat the bearing in the valve housing using Tool T65P-3524-A1 (Fig. 11). Be sure the bearing rotates freely.
4. Dip a new oil seal in gear lubricant, Standard Transmission Lubricant, (SAE 80W) D8DZ-19C547-A (ESP-M2C83-C) or equivalent and place it in the housing with the metal side facing outward. Drive the seal into the housing until the outer edge does not quite clear the snap ring groove (Fig. 12).
5. Place the snap ring in the housing and drive on the ring using Tool T65P-3524-A1 until the snap ring seats in its groove (Fig. 12).

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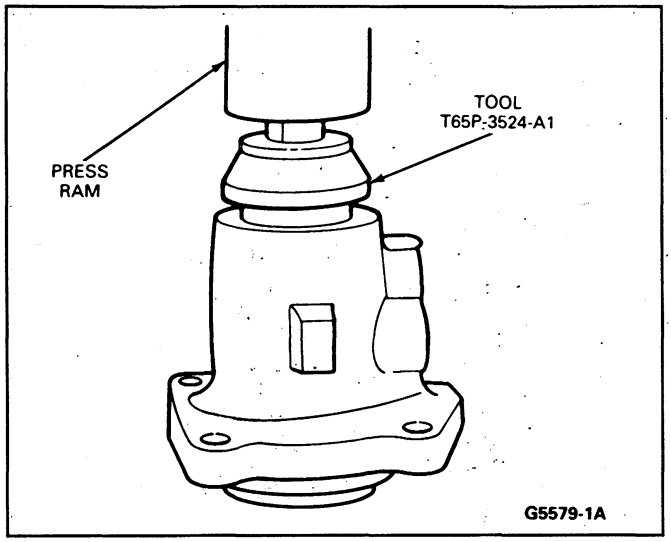


FIG. 11 Installing Valve Housing Bearing

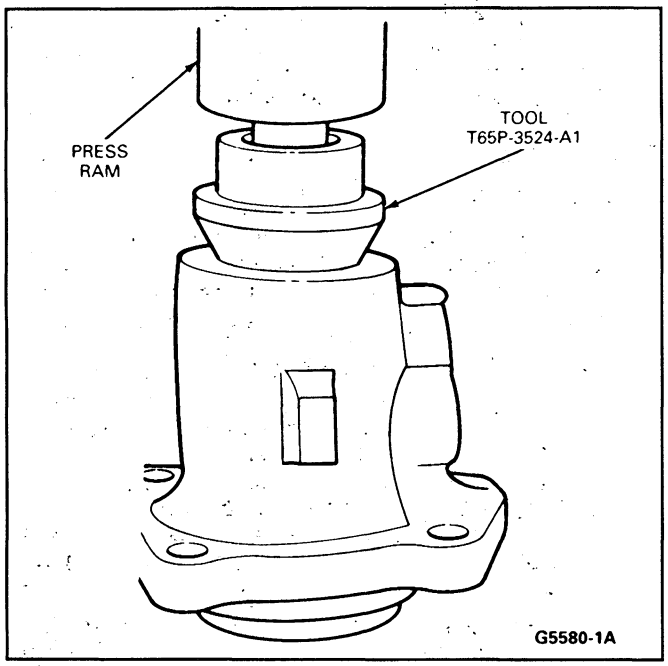


FIG. 12 Installing Oil Seal in Valve Housing

6. Place the dust seal in the housing with the dished side (rubber side) facing out. Drive the dust seal into place using Tool T65P-3524-A1 (Fig. 12). When properly installed, the seal will be located behind the undercut in the input shaft.
7. Pack the area between the two seals with clean Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent.

Worm and Valve Sleeve

Disassembly

1. Remove valve sleeve rings from sleeve by inserting the blade of a small pocket knife under them and cutting them off (Fig. 13).
2. Mount the worm end of the worm and valve sleeve assembly into a soft-jawed vise (Fig. 14).

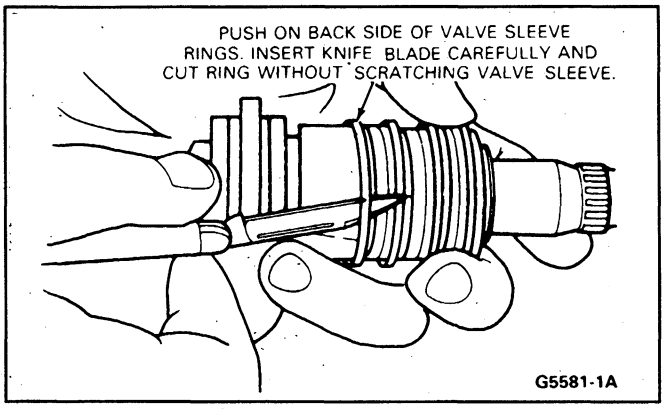


FIG. 13 Removing Valve Sleeve Rings

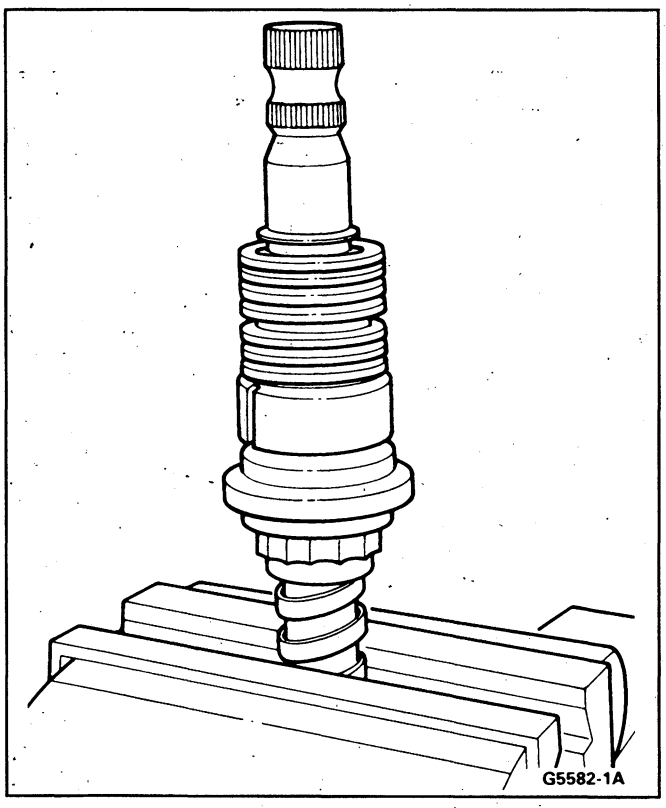


FIG. 14 Worm and Sleeve with Ring Removed

Assembly

1. Install mandrel Tool T75L-3517-A1 from the seal Installation Set over the sleeve; slide one valve sleeve ring over the tool (Fig. 15).
2. Slide the pusher Tool T75L-3517-A2 over the mandrel; rapidly push down on the pusher tool, forcing the ring down the ramp and into the fourth groove of the valve sleeve. Repeat this step three more times, and each time add one of the spacers, Tool T75L-3517-A3, under the mandrel tool. By adding the spacer each time, the mandrel tool will line up with the next groove of the valve sleeve (Figs. 16 and 17).
3. After installing the four valve sleeve rings, apply a light coat of gear lubricant Standard Transmission Lubricant (SAE 80W), D8DZ-19C547-A (ESP-M2C83-C) or equivalent to the sleeve and rings.

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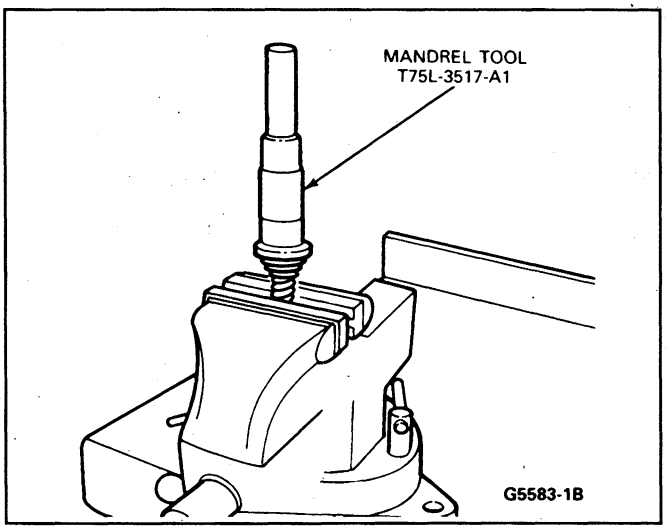


FIG. 15 Mandrel Installed on Sleeve

4. Install one spacer, T75L-3517-A3, over the input shaft as a pilot for installing the sizing tube. Slowly install the sizing tube Tool T75L-3517-A4, over the sleeve valve end of the worm shaft onto the valve sleeve rings. Make sure that the rings are not being bent over as the tube is slid over them (Figs. 18 and 19).
5. Remove the sizing tube and check the condition of the rings. Make sure that the rings turn freely in the grooves. Fig. 20 shows the complete set of tools needed to perform the above operations. The tool Kit Number for the complete set is T75L-3517-A.

   NOTE: No further service or disassembly of the worm valve assembly is possible. Valve centering will be destroyed if disassembly is attempted.

Piston

Disassembly

1. Remove the Teflon piston ring and O-ring (Fig. 4) from the piston and ball nut. Discard both rings.

Assembly

1. Dip a **new** O-ring in gear lubricant and install it on the piston and ball nut.
2. Install a **new** Teflon piston ring on the piston and ball nut being careful not to stretch it any more than necessary.

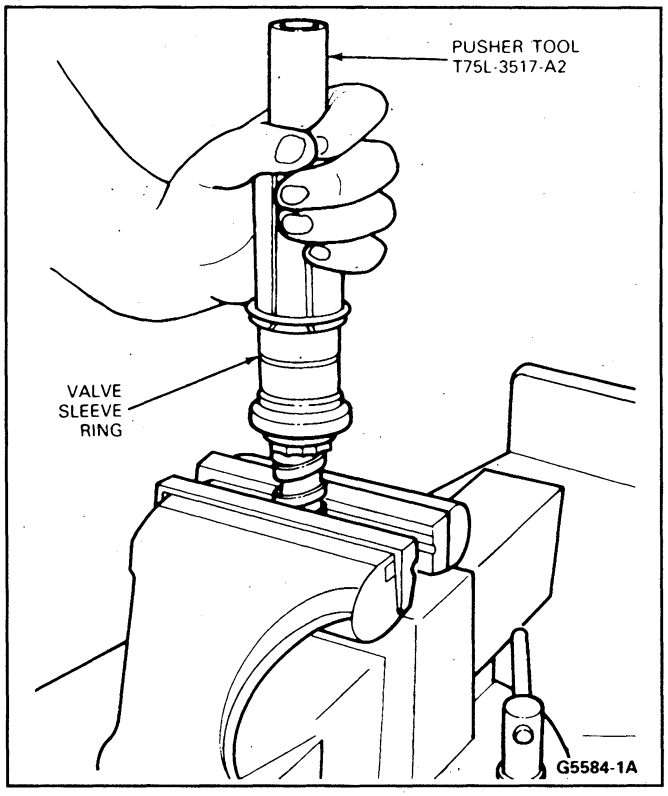


FIG. 16 Installing Ring on Valve

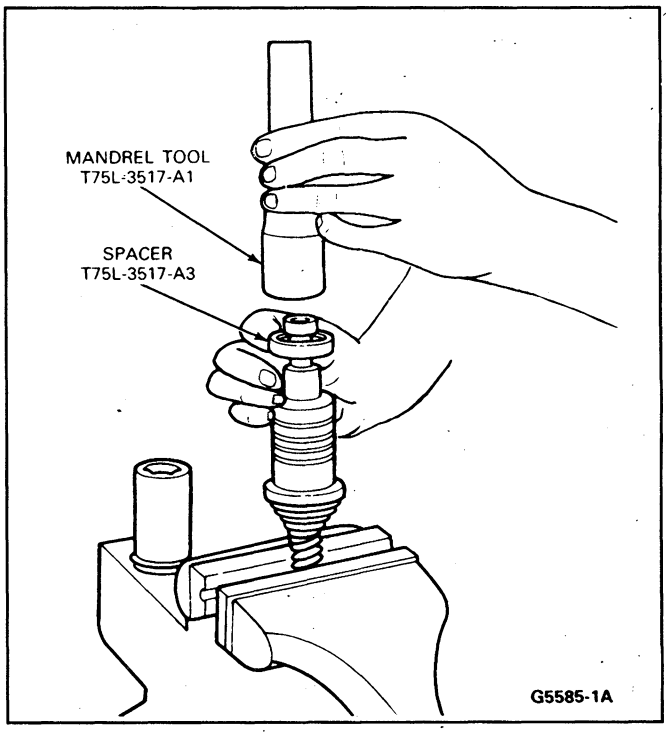


FIG. 17 Adding Spacer to Install Next Ring

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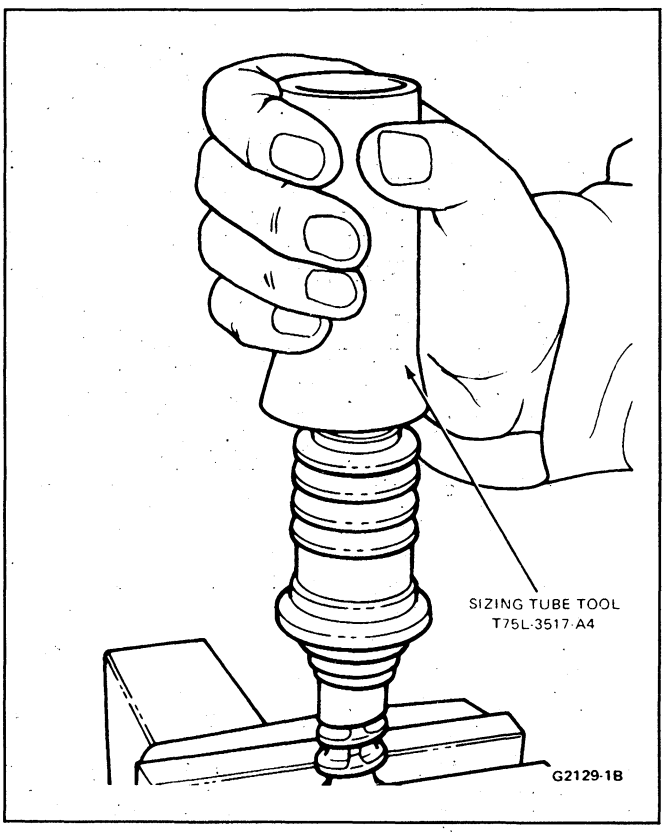


FIG. 18 Sizing Rings—Step 1

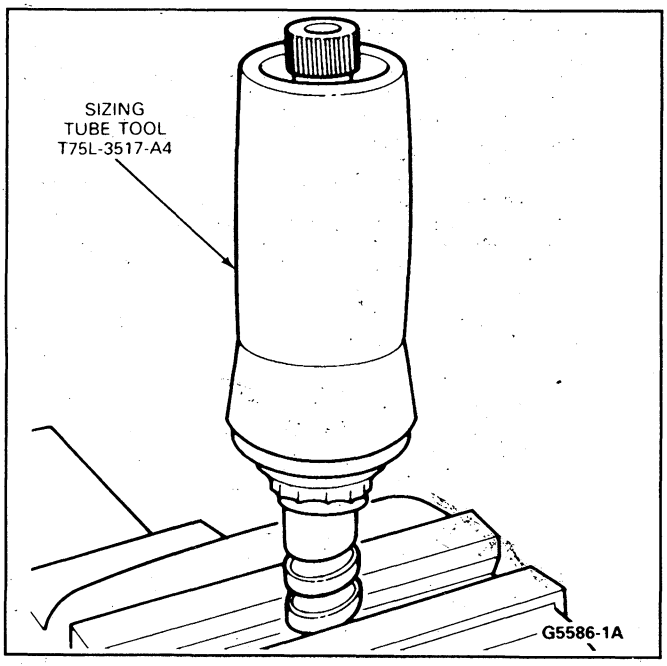


FIG. 19 Sizing Rings—Step 2

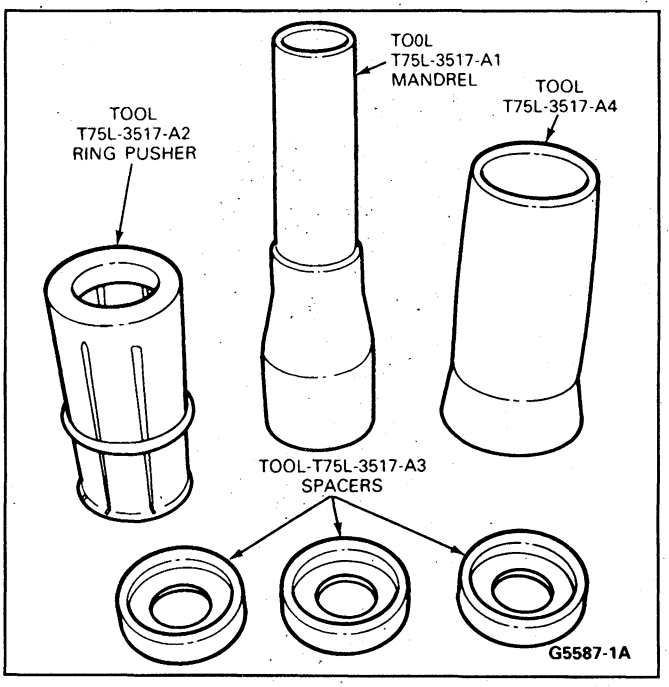


FIG. 20 Seal Installation—Tool T75L-3517-A

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SPECIFICATIONS

FORD INTEGRAL POWER STEERING GEAR SPECIFICATIONS

Description	
Type	Recirc. Ball Torsion Bar
Ratio	17:1
Turns of Steering Wheel (Lock to Lock — Linkage Disconnected)	4
Fluid Capacity (Included in Pump Reservoir Fill)	.75L (1.6 Pint Approx.)
Fluid Specification	ESW-M2C33-F②
Worm Bearing Preload (Overall Input Shaft Torque with Sector Shaft Removed)	0.45-1.0 N•m (4-9 in-lbs)①
Worm to Piston Preload	0.11-0.34 N•m (1-3 in-lbs)①

①Not adjustable in field. Specification given for inspection purposes only.
②C1AZ-19582-A, C, or D or equivalent.

FORD INTEGRAL POWER STEERING GEAR TORQUE LIMITS

	Torque Limits	
Description	(ft-lbs)	N•m
Sector Shaft Cover Bolts	55-70	75-94
Mesh Load Adjusting Screw Lock Nut	34-45	48-61
Valve Housing to Gear Housing Bolt	35-50	48-67
Rack Retaining Nut	55-90①	75-122
Piston End Cap	70-110	95-149
Pressure Hose to Gear	16-25	22-33
Return Hose to Gear	25-34	34-46
Hose Clamps	1-2	1.4-2.7
Pitman Arm to Sector Shaft Nut	190-230	230-310
	(in-lbs)	N•m
Ball Return Guide Clamp Screw	42-70	4.8-7.9
Set Screw Race Nut	15-25	1.7-2.8

①Specified Torque — Because the length of the tool required to torque the nut will affect the observed torque reading on the torque wrench, the torque reading should be computed using the length of the torque wrench and the nominal specified torque as follows:

$$\text{Torque Reading} = \frac{\text{Length of Torque Wrench} \times 72 \text{ ft-lbs}}{\text{Length of Torque Wrench} + 5.5 \text{ Inches}}$$

(Using Tool T66P-3553-B)

Example: With 13 inch torque wrench

$$\frac{13 \text{ In.} \times 72 \text{ ft-lbs}}{13 \text{ In.} + 5.5 \text{ In.}} = \frac{13 \text{ In.} \times 72 \text{ ft-lbs}}{18.5 \text{ In.}} = 0.703 \times 72 \text{ ft-lbs} = 50 \text{ ft-lbs}$$

MESHLOAD CHECKING AND SETTING

Vehicles with 0-8046 km (0-5000 Miles)	Vehicles with More Than 8046 km (500 Miles) or Where Sector Shaft Has Been Replaced
CHECKING: Reset if total meshload over mechanical center is less than 1.9 N•m (15 in-lbs) or greater than 2.9 N•m (25 in-lbs).	**CHECKING:** Reset if meshload measured while rocking input shaft over center is less than 0.8 N•m (7 in-lbs) greater than the torque 45° from the right stop.
RESET: Set torque measured rocking across center to a value of 1.6-2.0 N•m (14-18 in-lbs) greater than that measured 45° from the right stop.	**RESET:** Set torque measured rocking across center to a value 1.13-1.6 N•m (10-14 in-lbs) greater than that measured 45° from the right stop.

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SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T58L-101-B	Puller Attachment	Replaces T58L-101-A
T57L-500-B	Bench-Mounted Holding Fixture	Universal
TOOL-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T74P-3504-L	Brass Tube Seat Remover	Tube Seat Removal
T74P-3504-M	Brass Tube Seat Replacer	Tube Seat Installation
T75L-3517-A	Seal Installation Set	Ford Integral Power Steering Gear
T65P-3524-A	Input Shaft Bearing/Seal Tool	Ford Integral Power Steering Gear — For Needle Bearing Removal and Installation
T66P-3553-B	Adjuster and Locknut Wrench	Ford Integral Power Steering Gear — For Worm Bearing Adjuster and Locknut — Use with Spacer — Valve Housing to Piston
T66P-3553-C	Spacer — Valve Housing to Piston	Ford Integral Power Steering Gear — Use with Adjuster and Locknut Wrench
T77L-3576-A	Sector Shaft Seal Replacer	Ford Integral Power Steering Gear
T64P-3590-F	Pitman Arm Puller	Universal
D79L-7000-A	Retaining Ring Pliers	Internal and External Retaining Rings
T71P-19703-C	O-Ring Tool	Universal
T68L-33610-AB	Thermometer	Use with Power Steering Analyzer
D79L-33610-A	Power Steering Analyzer	All Vehicles

CG3137-2F

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SECTION 13-48 C-300N Hydraulic Power Steering Gear—Bendix

SUBJECT	PAGE
ADJUSTMENT	
Adjusting the Piston to Output Shaft Gear Backlash	13-48-26
CLEANING AND INSPECTION	
Cleaning	13-48-18
Inspection	13-48-19
DESCRIPTION AND OPERATION	
Description	13-48-1
Operation	13-48-2
DIAGNOSIS AND TESTING	13-48-7
DISASSEMBLY AND ASSEMBLY	
Housing and Side Cover	13-48-15
Steering Gear	13-48-11
REMOVAL AND INSTALLATION	
Steering Gear	13-48-8
SPECIFICATIONS	13-48-29
VEHICLE APPLICATION	13-48-1

VEHICLE APPLICATION

All F-Super Duty Commercial Stripped Chassis Vehicles and Motor Home Chassis Vehicles

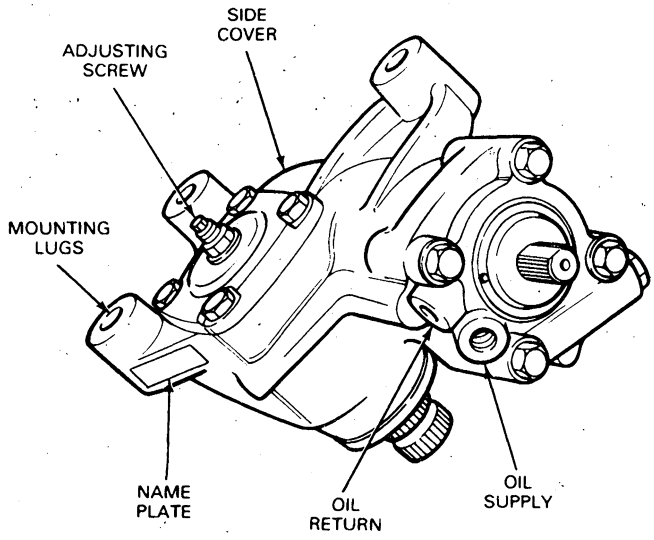
DESCRIPTION AND OPERATION

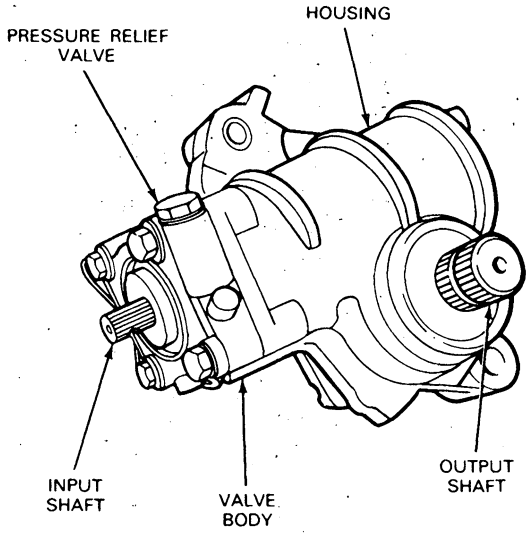
Description

The Compact 300N, or C-300N, Hydraulic Power Steering Gear is designed for medium duty vehicles with front axle weight ratings of 6,000 to 9,000 lbs.

It is an integral power steering gear incorporating the mechanical and hydraulic actuation and control components in a single cast housing which serves as the power cylinder.

The vehicle's steering column is coupled to the gear at the input shaft which transmits steering effort through a recirculating ball screw (spindle assembly) and piston. The piston is an integral part of the power assist and also acts as a steering damper. The direction and degree of power assist is controlled by a rotary hydraulic valve which is integral to the input shaft and spindle assembly. An engine driven hydraulic pump supplies the flow and pressure.





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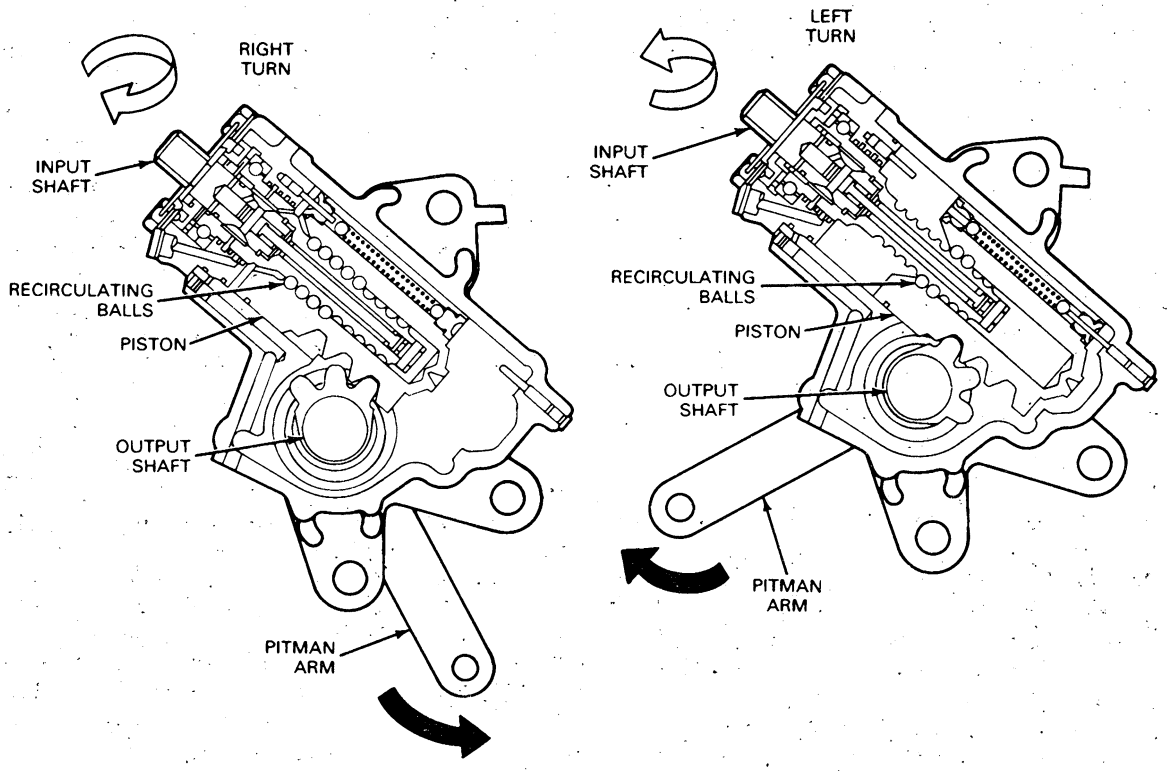
DESCRIPTION AND OPERATION (Continued)

Operation

The C-300N Integral Power Steering Gear is composed of both mechanical and hydraulic power assist components.

Actual steering is accomplished mechanically. Effort applied at the vehicle's steering wheel results in mechanical movement within the steering gear which causes the vehicle to change its direction of travel. The hydraulic power assist components function solely to reduce the mechanical effort required to turn the vehicle's steering wheel. Loss of hydraulic power will in no way prevent the vehicle from being maneuvered mechanically, however greater effort will be required to turn the steering wheel.

MECHANICAL OPERATION



G6224-2A

The turning effort exerted by the driver on the steering wheel is transmitted to the input shaft which is part of the spindle assembly. The spindle and piston function like a screw and nut through the action of a chain of recirculating balls that serve as an interface. Rotation of the spindle causes axial movement of the piston within the power cylinder. Gear teeth, cut directly into the piston, mesh with corresponding gear teeth on the output shaft. As the piston moves, the output shaft and the attached pitman arm are rotated.

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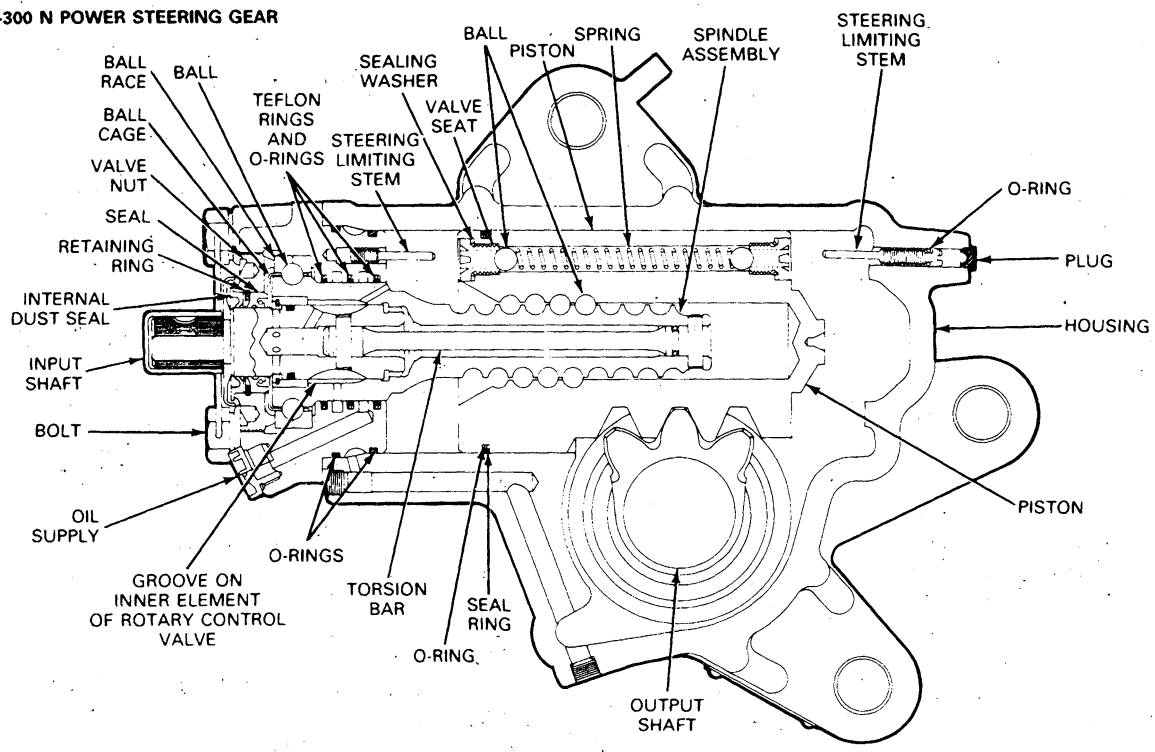
DESCRIPTION AND OPERATION (Continued)

Hydraulic Operation

Functioning together, the spindle and valve body assemblies serve as a means of flow and pressure control for the power assist portion of the steering gear. All hydraulic fluid enters and exits the power steering gear through lines connected to the threaded ports in the valve body.

The valve body assembly forms a closure for the housing and provides a means of retaining the spindle assembly. It contains a series of circular channels and radial passages which serve to direct the flow of hydraulic oil into the out of the rotary control valve in the spindle assembly. In addition, the valve body contains a pressure relief valve. The pressure relief valve ensures that a preset maximum pressure is not exceeded. It is always set at a pressure level below that of the power steering pump relief valve and is intended to limit the power assist to a specific maximum level.

C-300 N POWER STEERING GEAR

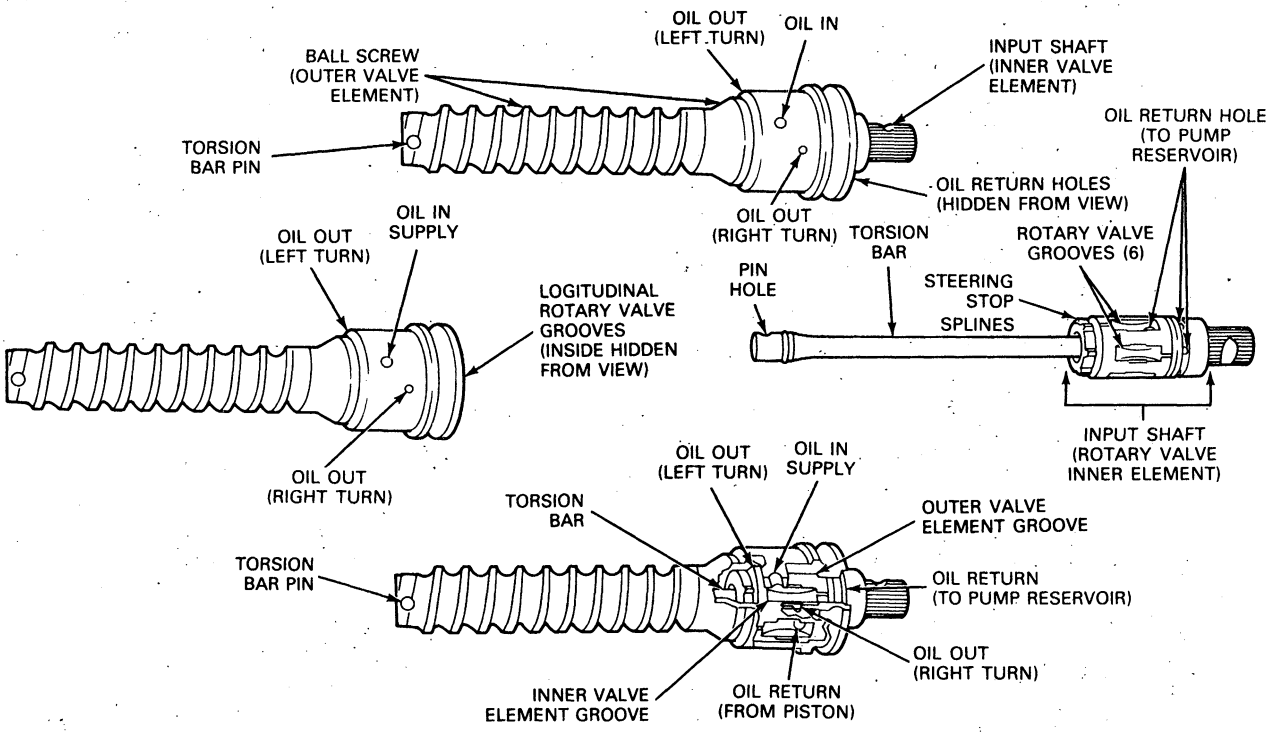


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DESCRIPTION AND OPERATION (Continued)

The spindle assembly rotates on a ball bearing in the bore of the valve body. The spindle is composed of three major parts; the input shaft, torsion bar, and ball screw. One end of the input shaft is finely splined for connection to the steering column while the other end has a coarse spline which mates loosely with a similar spline inside the ball screw. The coarse splines form mechanical stops which limit the amount of relative rotation between the ball screw and input shaft. Six evenly distributed longitudinal grooves are machined into the outer surface of the input shaft and correspond to six grooves machined into the bore of the ball screw. The torsion bar is pinned to the ball screw and input shaft and forms a spring connection between the two. With the input shaft inserted into the ball screw the six grooves of each of these components alternate with each other and form the hydraulic rotary control valve. Holes on the outside surface of the ball screw extend into the six grooves within its bore.



SPINDLE ASSEMBLY WITH ROTARY VALVE COMPONENTS G6276-2A

These holes allow pressurized oil to enter and exit the two parts of the rotary control valve. There are three groups of holes in the ball screw. Each group is made up of three different size holes which form a diagonal line across the surface of the ball screw. The largest hole in each group conducts pressurized oil into the grooves of the rotary control valve. The second largest hole in each group conducts oil out of the rotary control valve to the side of the power piston furthest from the rotary control valve while the smallest hole conducts oil to the closest side of the piston.

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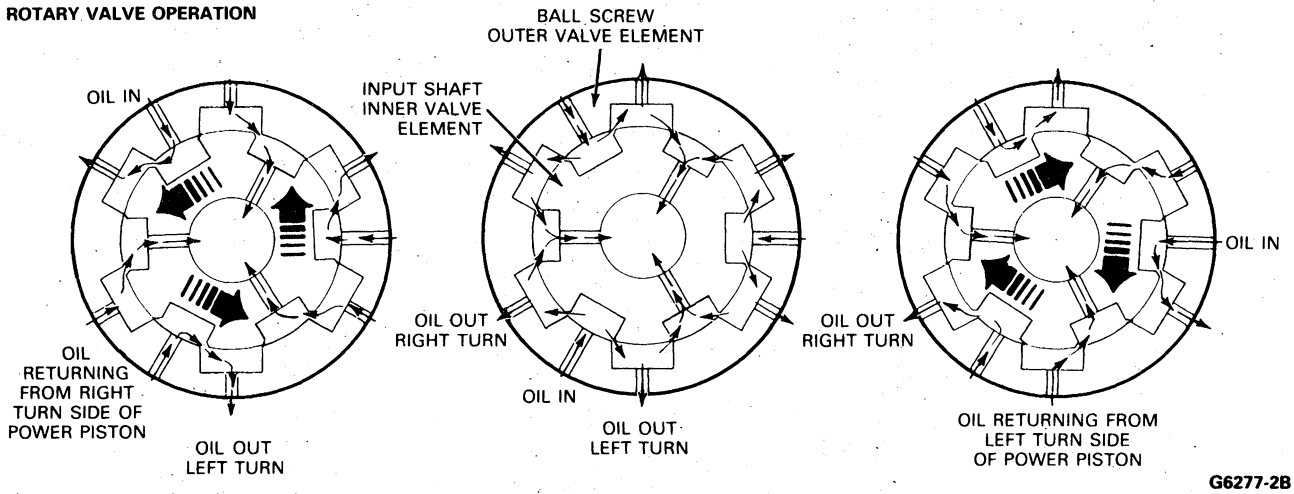
DESCRIPTION AND OPERATION (Continued)

Rotary Control Valve Operation

The rotary control valve is an open center type which allows a continuous flow of oil (through the longitudinal grooves in the input shaft and bore of the ball screw) when held in the neutral position by the torsion bar.

When steering effort is applied, the input shaft and ball screw tend to turn in unison, however the spring action of the torsion bar results in the input shaft rotating slightly in advance of the ball screw. The six pairs of grooves that form the rotary control valve are displaced from their neutral flow position. As steering effort increases, so does the amount of displacement. Depending on the direction steered, the groove displacement of the input shaft directs hydraulic oil through the appropriate drilled passages in the ball screw to one side or the other of the piston.

ROTARY VALVE OPERATION



G6277-2B

Hydraulic pressure acting upon the piston surface eliminates much of the piston's resistance to movement. Spring force exerted by the torsion bar causes the ball screw to rotate as piston resistance is removed. As the ball screw rotates, the relative groove displacement is eliminated and the rotary valve returns to a neutral position.

Moderate effort at the steering wheel procedures smaller valve displacements and lower power assist, thus providing good steering feel. At increased displacements, the pressure rises more rapidly giving increased power assistance and quicker response. Maximum pressure is developed after approximately 3 1/3 degrees displacement giving a direct feel to the steering. Groove displacement is limited by the freeplay of the stop spline mesh between the input shaft and ball screw. The splines take up the steering movement while allowing the torsion bar to hold the groove displacement. The torsion bar and stop splines form two parallel means of transmitting the steering torque. When no steering torque is applied, the torsion bar returns the valve grooves to a neutral position allowing the pressurized oil to flow to the return line.

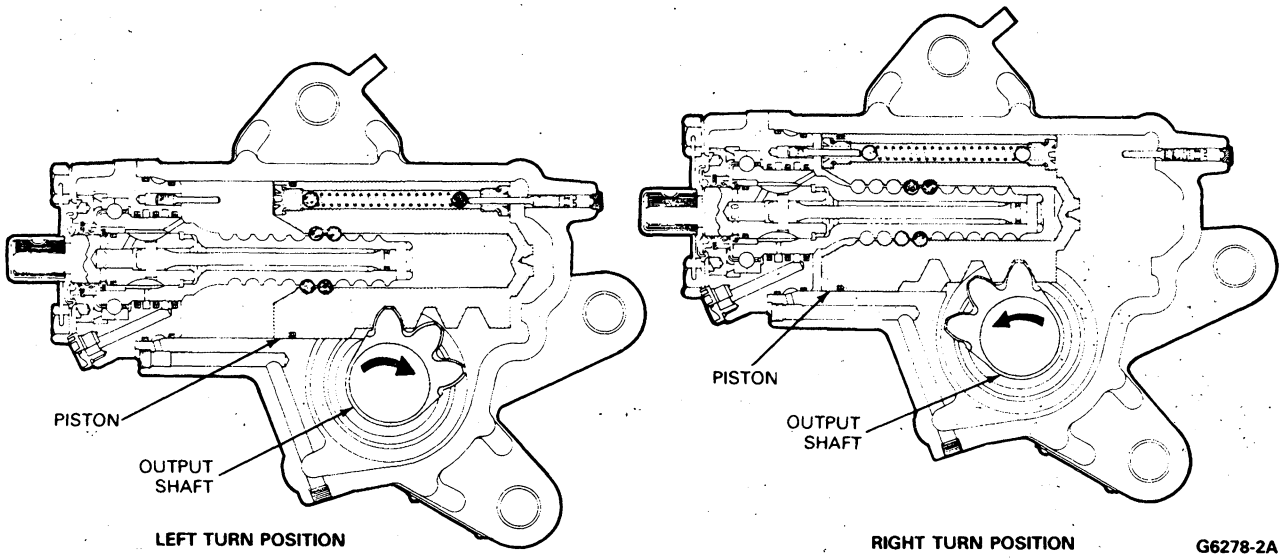
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DESCRIPTION AND OPERATION (Continued)

Steering Limiting Valve Operation

In steering gears equipped with steering limiting valves, power assisted movement of the piston within its bore is limited by poppet valves installed in both piston faces. As the piston approaches its extreme travel in either direction a stern unseats the steering limiting poppet valve. Some hydraulic power assist is removed as pressurized oil passes through the poppet valve to the other side of the piston and to the return line. Continued movement of the piston will result in removal of increasing amounts of power assist and cause increased steering effort. Steering limiting reduces the maximum power assist that can be transmitted to the axle steering linkages and components.

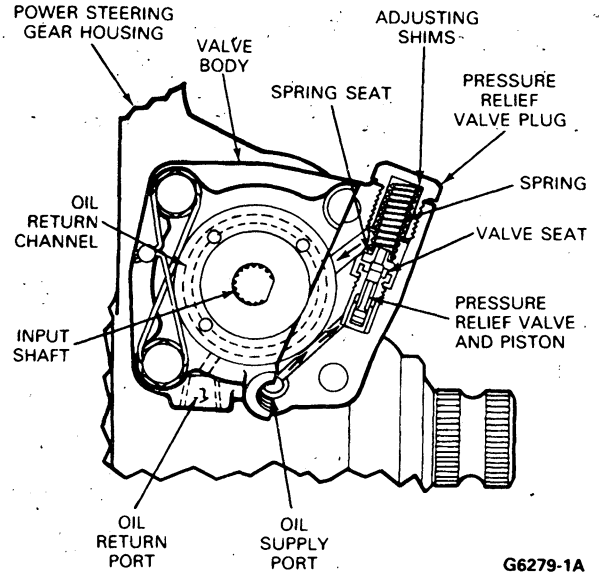
C-300 N POWER STEERING GEAR (OPERATIONAL VIEWS)



Pressure Relief Valve Operation

Located in the valve body the pressure relief valve limits hydraulic pressure within the power steering gear to a preset maximum. It is always set to a pressure lower than the relief valve on the power steering pump.

PRESSURE RELIEF VALVE OPERATION

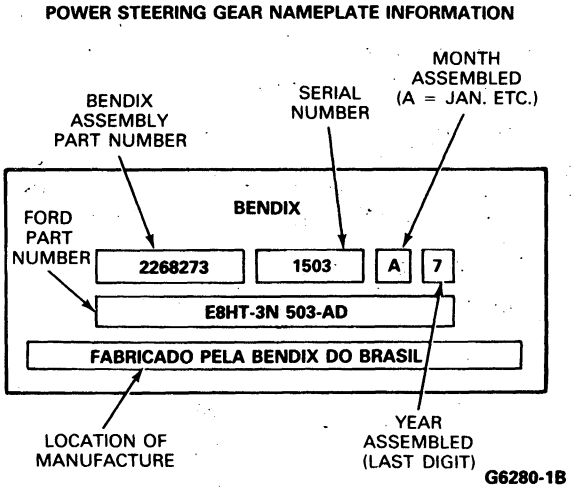


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DESCRIPTION AND OPERATION (Continued)

Power Steering Gear Identification

A nameplate is attached to the exterior of the housing generally on one of the mounting lugs.



Output Shaft Sector Teeth Adjustment

The gear lash between the piston teeth and sector gear should not require attention in normal service, however a provision for adjustment is provided.

Adjustment requires that the steering gear be drained and the Pitman arm and input shaft be disconnected from the vehicle. The adjustment procedure is described at the end of the assembly section of this manual.

Output Shaft Boot and Dust Seal

Inspect the integrity of the output shaft boot and dust seal. These components prevent contamination from entering the housing around the output shaft. If deterioration is noted, these components should be replaced.

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service.

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REMOVAL AND INSTALLATION

Steering Gear

During the steering gear removal observe the following precautions:

a. Drain steering assembly.

b. Thoroughly clean off all outside dirt, especially around fittings.

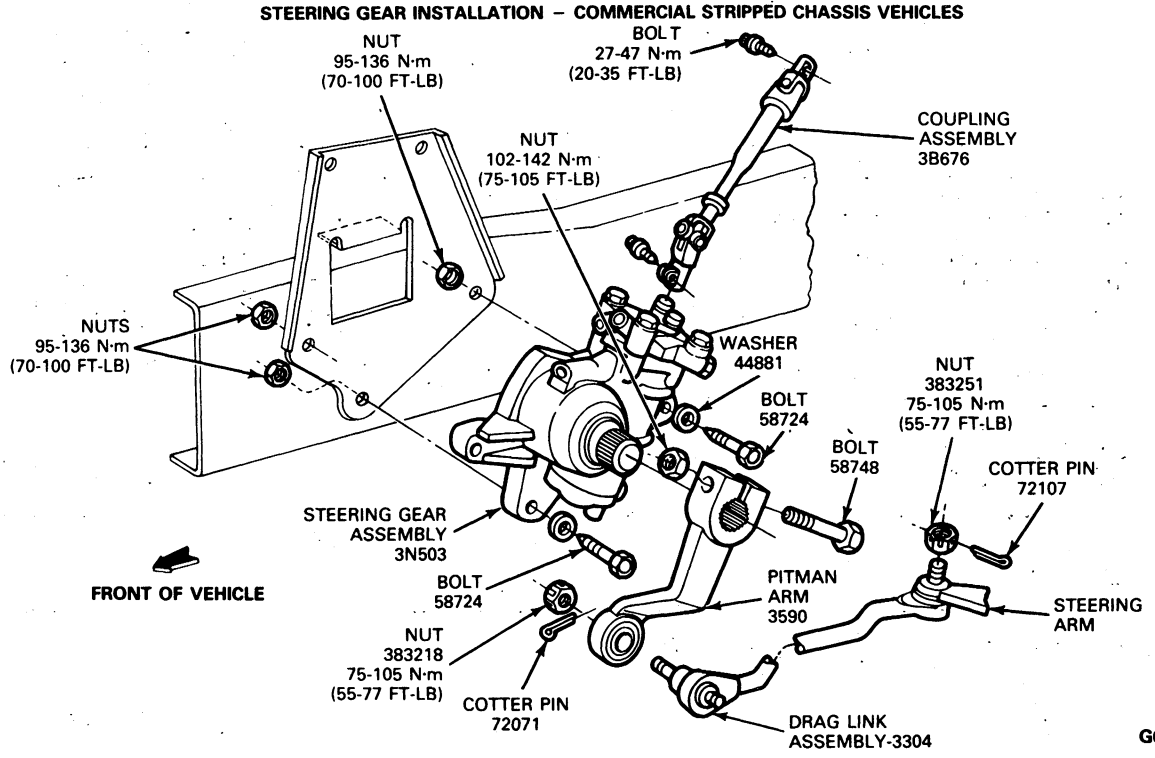
c. Plug all port holes immediately after removing hoses and before removing the gear from the vehicle. Mark or identify the inlet and return lines at the valve body ports.

d. Finish cleaning and dry the gear before placing on a work bench.

CAUTION: Never steam clean or high-pressure wash hydraulic steering assemblies. Do not force or abuse closely fitted parts, or damage will result.

CAUTION: Do not forcefully strike the steering gear input shaft or steering column coupling with a hammer or any other object during removal or installation of the steering column coupling. Severe internal damage to the steering gear can result.

STEERING GEAR INSTALLATION – COMMERCIAL STRIPPED CHASSIS VEHICLES



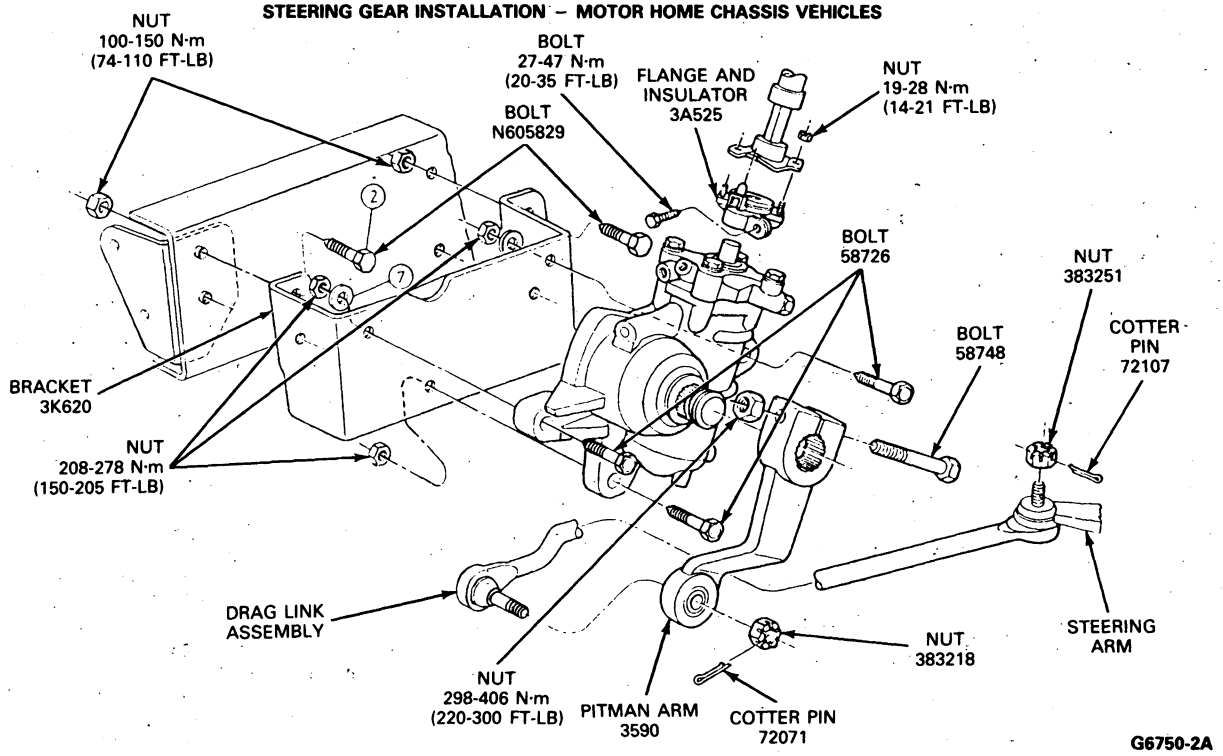
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REMOVAL AND INSTALLATION (Continued)

Removal

1. Disconnect the power steering pressure line at the gear.
2. Disconnect the power steering return line at the gear.
3. Remove the bolt and nut holding the Pitman arm to the sector shaft. Remove the Pitman arm from the sector shaft using steering Pitman arm remover Tool T64P-3590-F, or equivalent.
4. Remove the bolt and nut holding the U-joint to the steering gear input shaft.
5. Remove the bolts and nuts holding the steering gear to the frame side rail. Remove the steering gear.

STEERING GEAR INSTALLATION – MOTOR HOME CHASSIS VEHICLES



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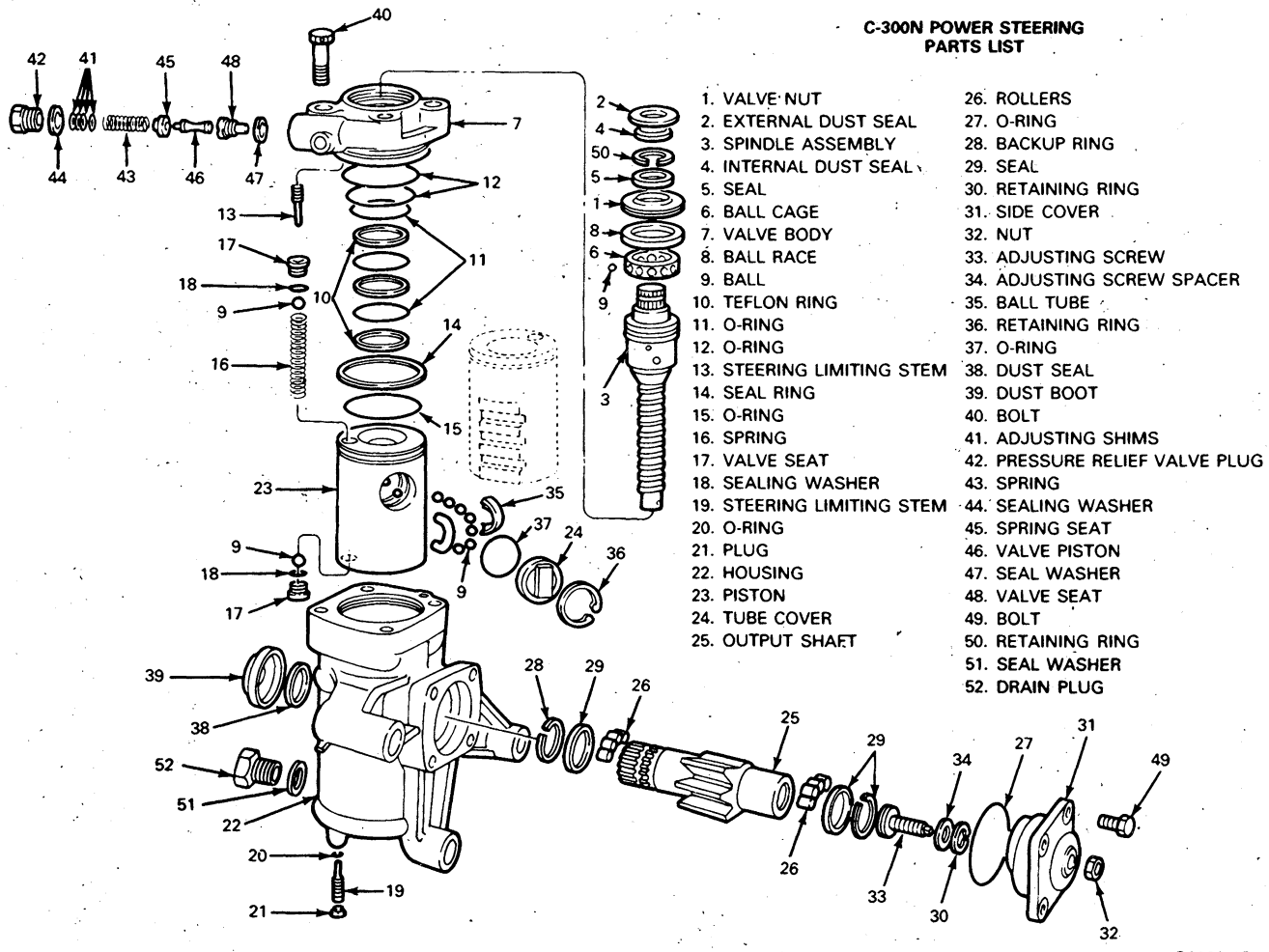
REMOVAL AND INSTALLATION (Continued)

Installation

1. Place the gear on the side rail. Install the bolts and nuts and tighten to 203-278 N·m (150-205 ft-lbs.).
2. Place the intermediate shaft U-joint on the steering gear input shaft. Tighten to 68-95 N·m (50-70 ft-lbs.).
3. Place the Pitman arm on the steering gear sector shaft, making sure the timing mark on the Pitman arm aligns with the timing mark on the sector shaft. Use a chisel to help spread the Pitman arm to slide onto the sector shaft.

WARNING: DO NOT USE A HAMMER TO FORCE THE PITMAN ARM ONTO THE SECTOR SHAFT. THIS MAY LEAD TO DAMAGE OF THE SECTOR SHAFT BEARINGS AND A LOSS OF GEAR PRELOAD.

4. Install the bolt and nut. Tighten the nut to 299-406 N·m (220-300 ft-lbs).
5. Connect the power steering pressure and return lines to the gear.
6. Fill the reservoir with fluid specified at the end of this Section.
7. Start the engine, turn the steering wheel from left to right, and check for fluid leaks.



C-300N POWER STEERING PARTS LIST

1. VALVE NUT
2. EXTERNAL DUST SEAL
3. SPINDLE ASSEMBLY
4. INTERNAL DUST SEAL
5. SEAL
6. BALL CAGE
7. VALVE BODY
8. BALL RACE
9. BALL
10. TEFLON RING
11. O-RING
12. O-RING
13. STEERING LIMITING STEM
14. SEAL RING
15. O-RING
16. SPRING
17. VALVE SEAT
18. SEALING WASHER
19. STEERING LIMITING STEM
20. O-RING
21. PLUG
22. HOUSING
23. PISTON
24. TUBE COVER
25. OUTPUT SHAFT
26. ROLLERS
27. O-RING
28. BACKUP RING
29. SEAL
30. RETAINING RING
31. SIDE COVER
32. NUT
33. ADJUSTING SCREW
34. ADJUSTING SCREW SPACER
35. BALL TUBE
36. RETAINING RING
37. O-RING
38. DUST SEAL
39. DUST BOOT
40. BOLT
41. ADJUSTING SHIMS
42. PRESSURE RELIEF VALVE PLUG
43. SPRING
44. SEALING WASHER
45. SPRING SEAT
46. VALVE PISTON
47. SEAL WASHER
48. VALVE SEAT
49. BOLT
50. RETAINING RING
51. SEAL WASHER
52. DRAIN PLUG

G6282-2B

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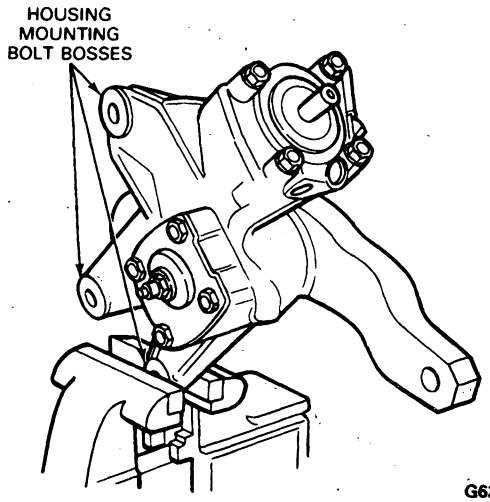
DISASSEMBLY AND ASSEMBLY

Steering Gear

Disassembly

A high level of cleanliness should be observed at all times when working on the power steering gear. Clean the exterior of all parts prior to disassembly.

After removing the power steering unit from the vehicle and cleaning the outside, secure the power steering unit to the work bench for disassembly. A large vise with jaw protectors may be used. Clamp across the mounting bolt bosses. (Do not overtighten.)

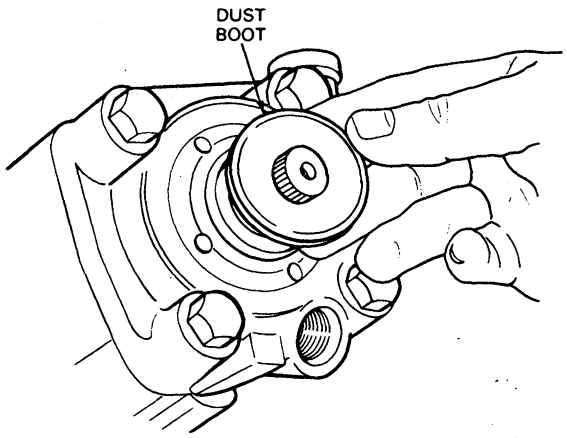


G6283-1A

NOTE: Following disassembly and assembly procedures is presented for reference purposes and presupposes that a major rebuild of the power steering gear is being undertaken. Several replacement parts and maintenance kits are available which do not require full disassembly. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here.

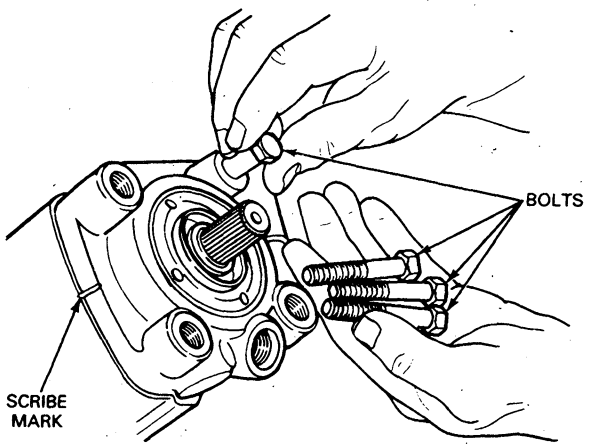
Input Shaft

1. Remove the external dust boot from the spindle assembly's input shaft spline.



G6284-1A

2. Scribe a line or otherwise mark the relationship of the valve body to the housing. Using a 19mm wrench remove the four bolts that secure the valve body to the housing.

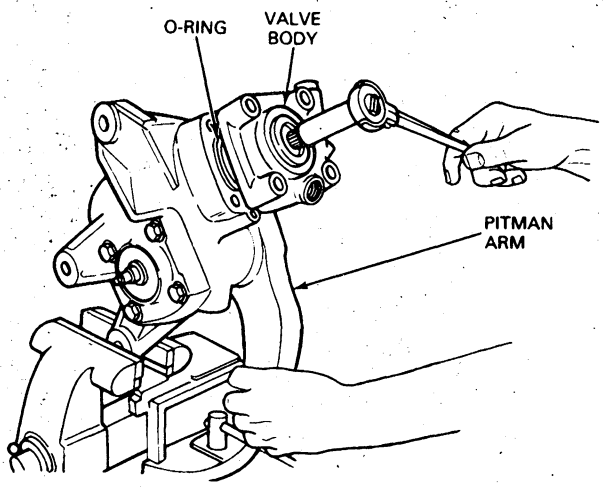


G6285-1A

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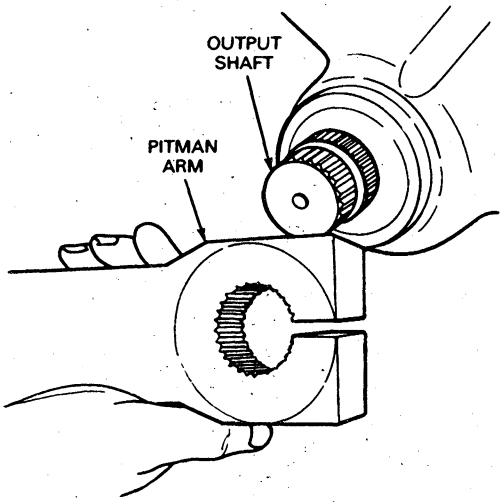
DISASSEMBLY AND ASSEMBLY (Continued)

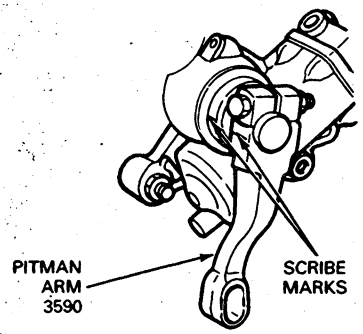
3. Separate the valve body from the housing by rotating the output shaft using the Pitman arm. It may be necessary to hold or rotate the input shaft during this operation. Continue to separate the valve body from the housing until both O-rings on the valve body can be seen.



G6286-1A

4. Scribe a line, or otherwise mark the relationship of the Pitman arm to the output shaft, then remove the Pitman arm.

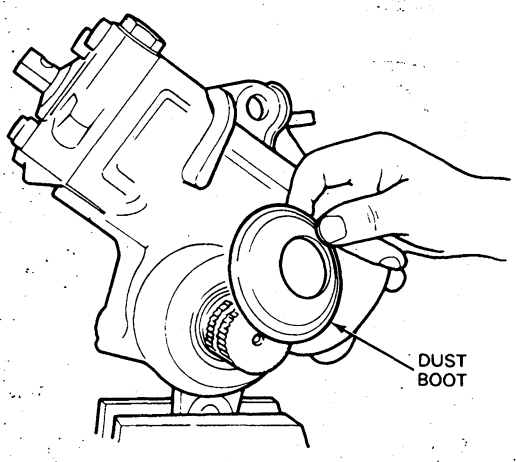




G6287-2B

5. Remove the dust boot.

   Remove any accumulated dirt, grease, grime, and corrosion from the exposed portion of the output shaft to facilitate removal through its seals.

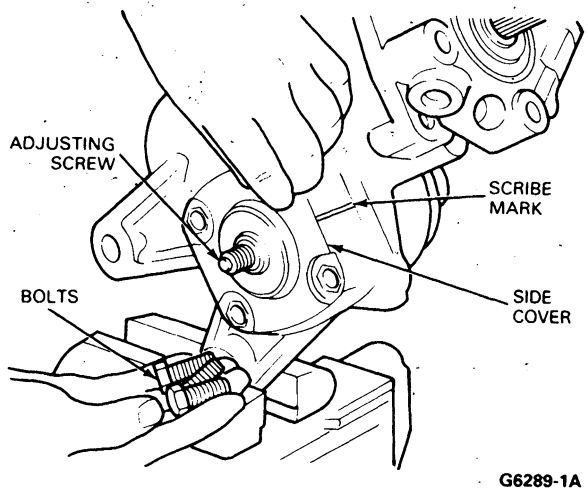


G6288-1A

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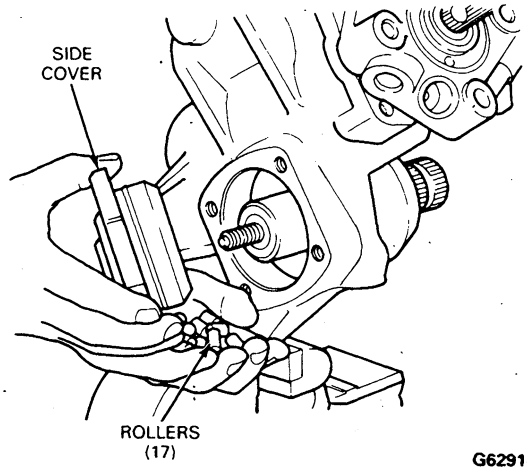
DISASSEMBLY AND ASSEMBLY (Continued)

6. Loosen and remove the lock nut from adjusting screw on the side cover using a 19mm wrench.
7. Scribe a line otherwise mark the relationship of the side cover to housing. Using a 19mm wrench, remove the four bolts that secure the side cover to the housing.



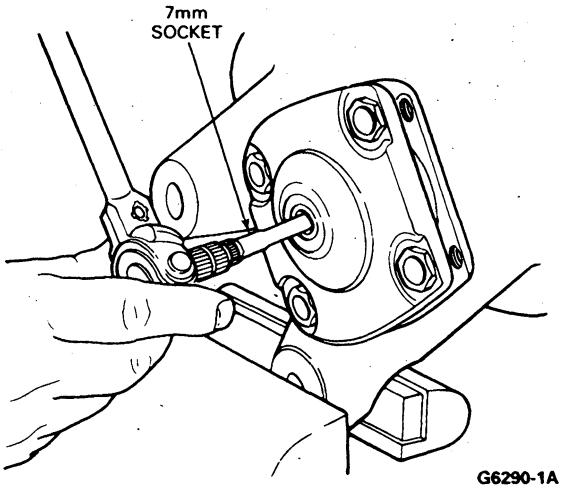
G6289-1A

When the side cover is removed from the housing the 17 rollers in the side cover bearing will fall out loose. These rollers MUST NOT BE INTERCHANGED with the rollers in the housing bearing which is identical.



G6291-1A

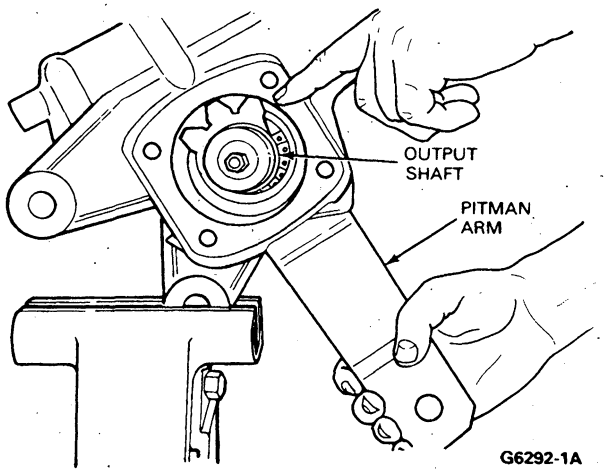
8. Separate the side cover from the housing by turning the adjusting screw clockwise with a 7mm socket. Continue turning the adjusting screw until the side cover can be removed from the housing.



G6290-1A

CAUTION: Do not attempt to remove the outer race of the roller bearing from the side cover.

9. Loosely install the Pitman arm and use it to center the piston and output shaft gear teeth inside the side cover opening of the housing.

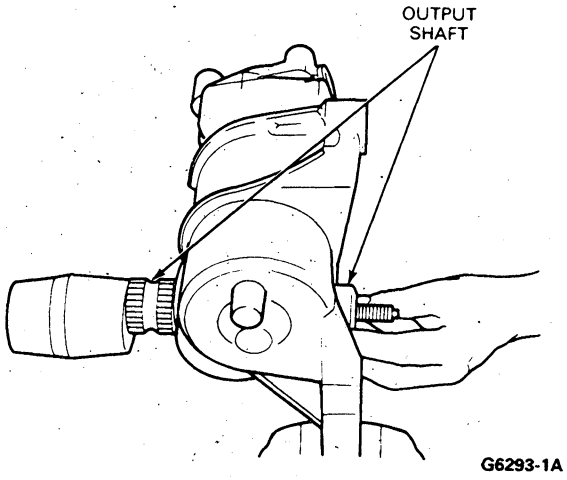


G6292-1A

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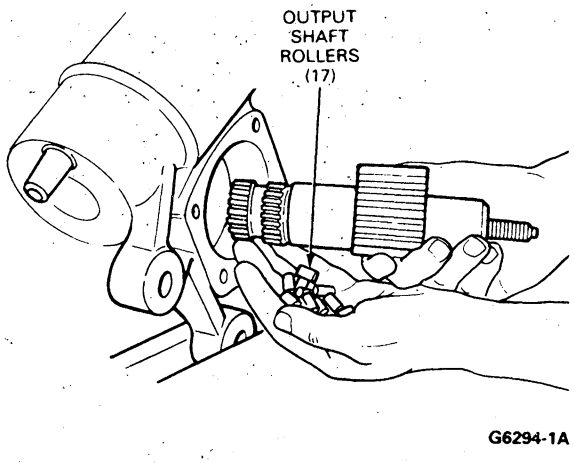
DISASSEMBLY AND ASSEMBLY (Continued)

Remove the Pitman arm and then remove the output shaft by tapping gently on the splined end with a soft mallet.



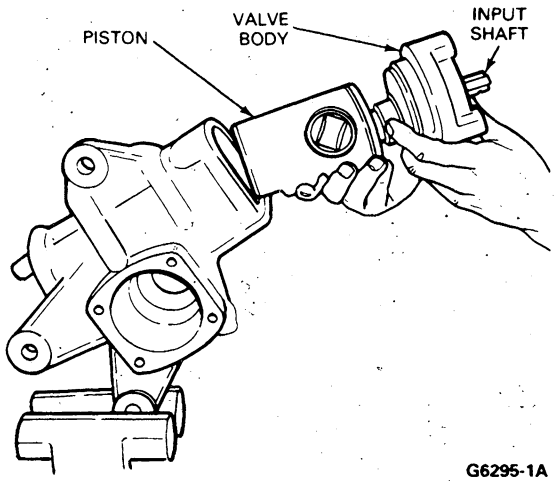
When the output shaft is removed from the housing, the 17 rollers in the housing bearing will fall out loose. These rollers MUST NOT BE INTERCHANGED with the rollers in the side cover bearing which is identical.

CAUTION: Do not attempt to remove the outer race of the roller bearing from the housing.



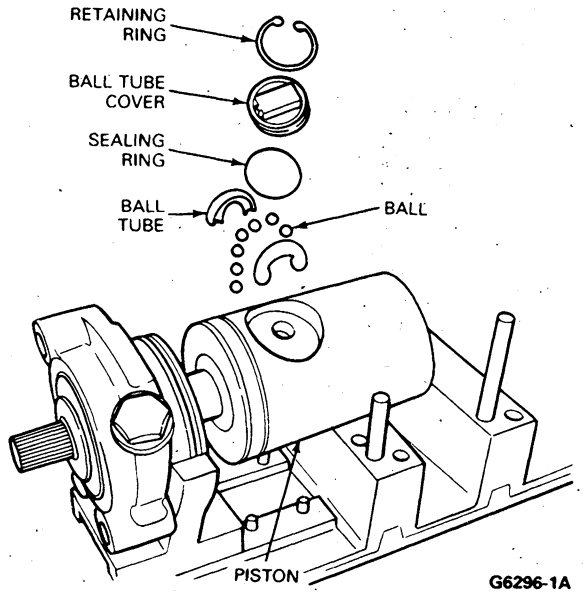
Piston

10. While preventing rotation of the input shaft end of the spindle assembly, pull the valve body and piston out of the housing.



11. Remove the retaining ring, ball tube cover, the ball tube and 7 of the 26 balls from the piston. Remove the sealing ring from the piston.

NOTE: Holding fixture (Bendix Tool 297678) which is pictured is a convenience but not a necessity for disassembly.

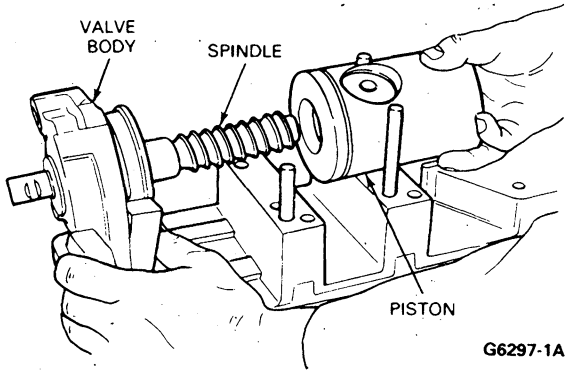


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DISASSEMBLY AND ASSEMBLY (Continued)

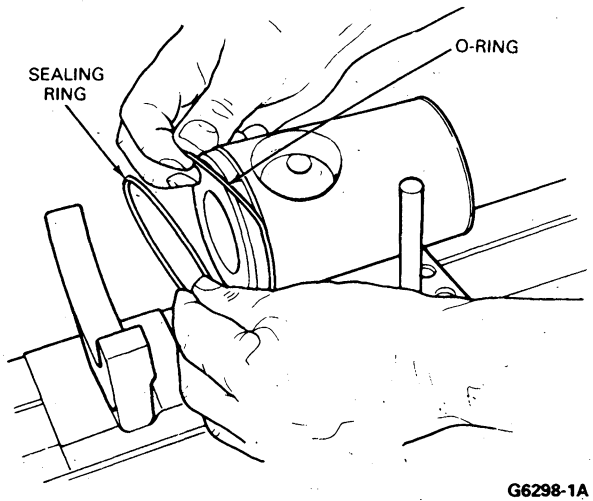
12. In order to remove the remaining 19 balls from piston, rotate the input shaft in the direction (clockwise or counterclockwise) that threads the spindle assembly OUT OF THE PISTON.

    Separate the valve body and spindle from the piston. Check the inside of the piston for any stray balls that may not have been removed in the operation above. A total of 26 balls, 7 from the ball tube and 19 from the piston, should be accounted for.



G6297-1A

13. Remove the sealing ring and O-ring below it from the groove in the piston.

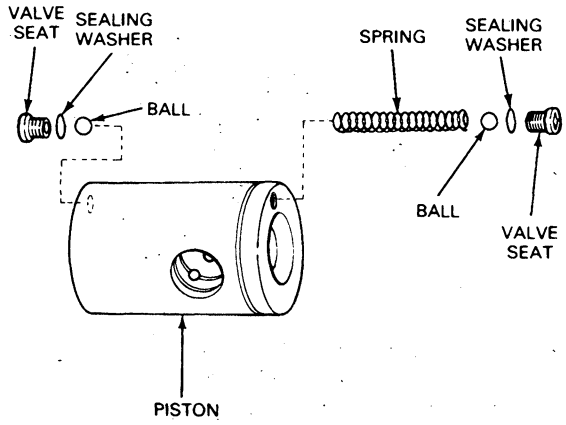


G6298-1A

14. Remove either of the steering limiting valve seats and sealing washer from the piston. Either a Phillips or straight blade screwdriver will be required, depending upon which of the two styles of body is in use.

NOTE: Care must be taken during this operation since damage to the screwdriver slot will make removal difficult.

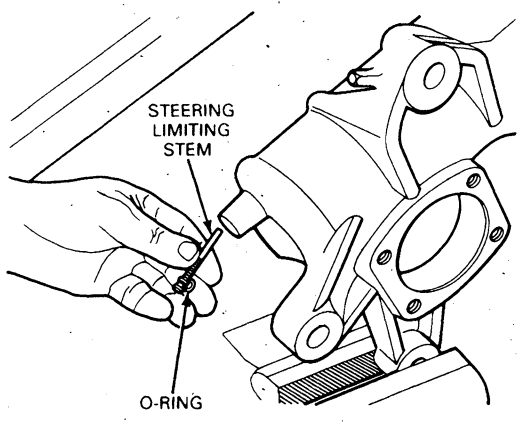
15. Remove one of the two balls the spring then the remaining ball. Referring to the previous step, remove the remaining steering limiting valve seat and its sealing washer from the other end of the piston.



G6299-1A

Housing and Side Cover

16. Remove the steering limiting stem protective plug from the housing. Using a screwdriver, remove the stroke limiting valve stem from the housing and separate the O-ring from the stem.



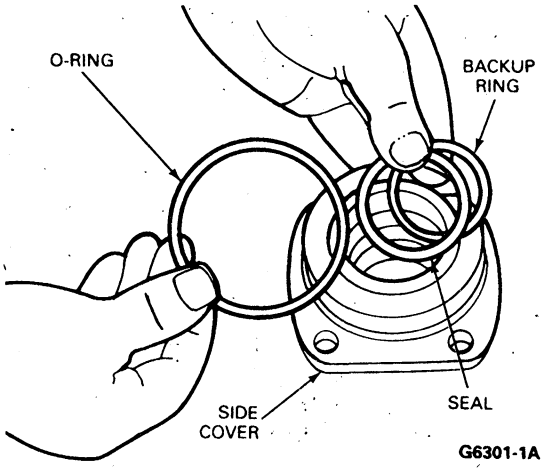
G6300-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

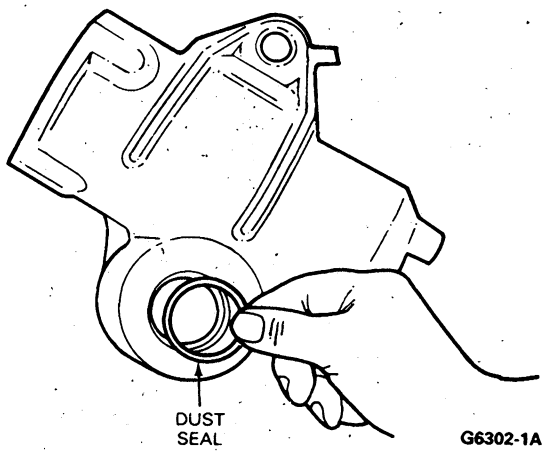
17. Remove the O-ring from the side cover. Remove the seal and its split nylon backup ring from the side cover bore. The nylon split ring comes out separately but is part of the seal.

Caution: Do not remove the outer race of the roller bearing from the side cover.



G6301-1A

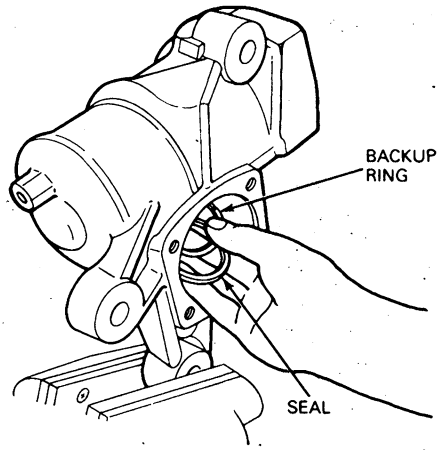
18. Carefully pry out and remove the dust seal from the housing.



G6302-1A

19. Reaching through the side cover opening of the housing remove the output shaft seal an its nylon backup ring which comes out separately but is part of the seal.

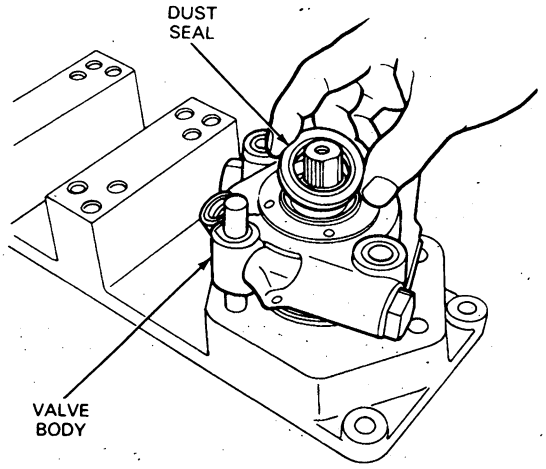
Caution: Do not remove the outer race of the roller bearing from the housing.



G6303-1A

Valve Body and Spindle

20. Remove the input shaft dust seal from the valve nut.

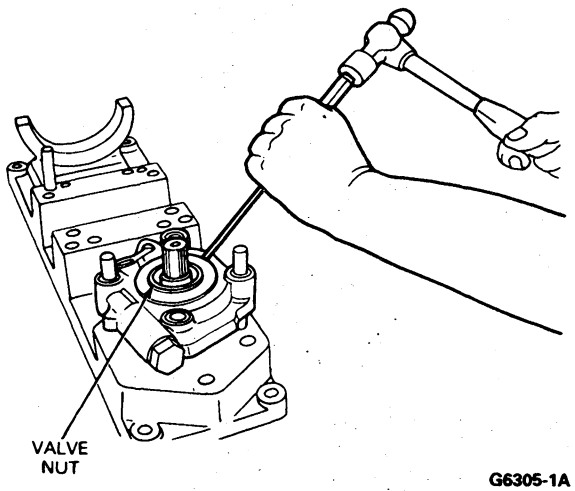


G6304-1A

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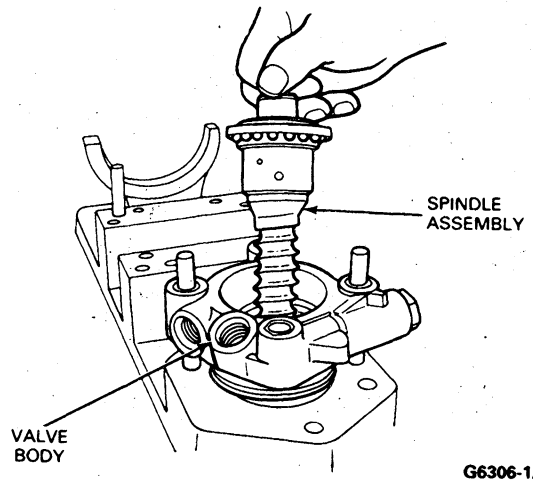
DISASSEMBLY AND ASSEMBLY (Continued)

21. With a drift punch, unblock the safety point between the valve nut and valve body. Using Spanner wrench Bendix Tool 106234, or equivalent loosen and remove the valve nut from the valve body.



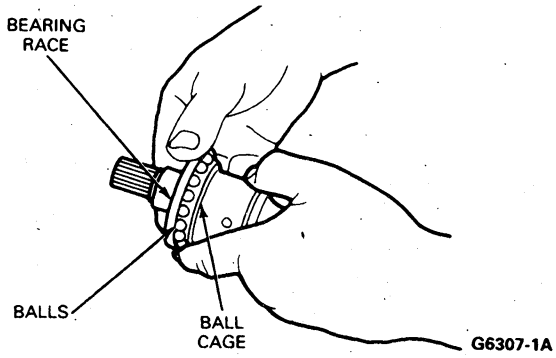
G6305-1A

22. Grasp the input shaft end of the spindle assembly and lift the spindle assembly, ball cage, 17 balls and one half of the outer race out of the valve body.



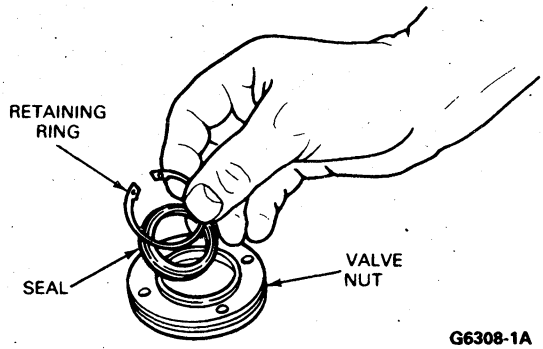
G6306-1A

23. Separate the outer race, ball cage and 17 balls from the spindle assembly.
24. Do not remove the other half of the ball bearing outer race in the valve body.



G6307-1A

25. Remove the retaining ring and then the seal from the valve nut.

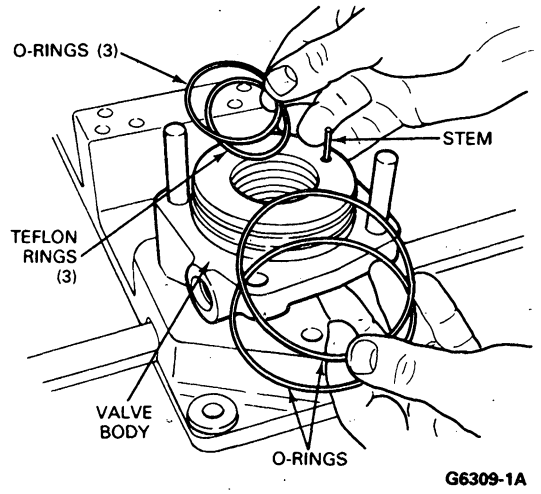


G6308-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

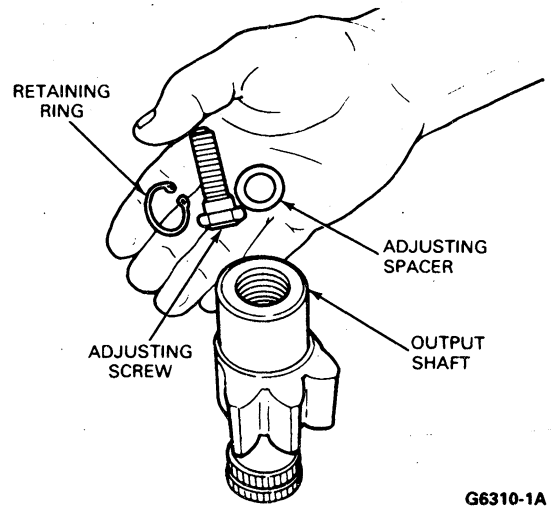
26. Remove the two outside O-rings from the valve body then remove the three Teflon rings and the corresponding three O-rings from the spindle bore.



27. If the steering gear is equipped with a steering limiting feature check the condition and length of the limiting stem in the valve body. The length of the stem measured from the surface of the valve body to the tip of the stem should be specified in the vehicle service manual. If the limiting stem is of the correct length and in good condition, **DO NOT REMOVE** it. The limiting stem can be removed if necessary by heating the poppet stem to loosen the locktite, and then turning counterclockwise.

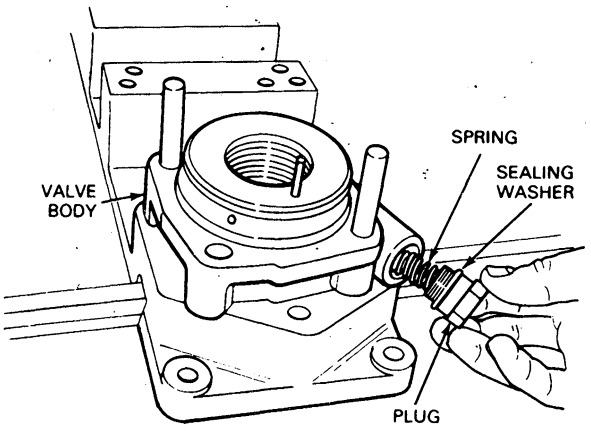
Output Shaft

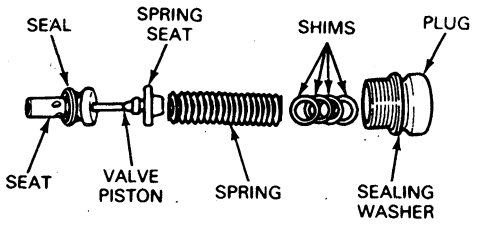
28. Remove the retaining ring, the adjusting screw spacer and the adjusting screw from the output shaft.



Pressure Relief Valve

29. Begin disassembly of the pressure relief valve by removing the plug and its sealing washer from the valve body.
30. Remove the spring, spring seat adjusting shims and the valve piston.





31. Using a wide bladed screwdriver or Bendix Tool 298080, remove the valve seat and its sealing washer.

Spindle

CAUTION: Do not attempt disassembly of the spindle assembly which contains the rotary valve. Individual replacement parts are NOT available. It must be treated as a single component.

NOTE: Additionally, the piston must be purchased (piston and spindle kit) due to the match of the grinding of the two components.

CLEANING AND INSPECTION

Cleaning

Wash all parts individually in clean solvent and dry thoroughly. All non-metallic parts should be discarded and replaced with new.

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CLEANING AND INSPECTION (Continued)

Inspection

Parts found broken, cracked, distorted, excessively pitted, or scored must be replaced. Cause for the replacement of any part should be investigated and corrected to prevent reoccurrence.

Visually inspect all parts carefully paying particular attention to:

1. Bearings and bearing surfaces should not exhibit brinelling, pitting, spalling or cracks. If upon inspection, it is determined that the outer races of the roller bearings contained in the housing or the side cover are not serviceable, the entire housing or side cover must be replaced. If the outer ball bearing race remaining in the valve body is not serviceable, the entire valve body must be replaced. Inspect the bearing surfaces of both the inputs.
2. Gear teeth in the output shaft and piston may show signs of polishing and slight wear, however, pitting, spalling, and cracks should not be present.
3. Output and input shaft splines.
4. Check the ball rolling surfaces on the exterior of spindle and interior of piston for cracks, pitting, spalling and brinelling.
5. Exterior of piston and interior of housing bore.

Note: Minor scuffing of the piston exterior and housing bore can be considered normal. If deep scoring is detected, the affected parts should be replaced as leakage will occur and steering control and reaction will be affected. Do not attempt honing or boring of these parts as leakage rates will increase.

6. Pitman arm.
7. Exterior of housing and its mounting lugs.
8. Valve body and porting.

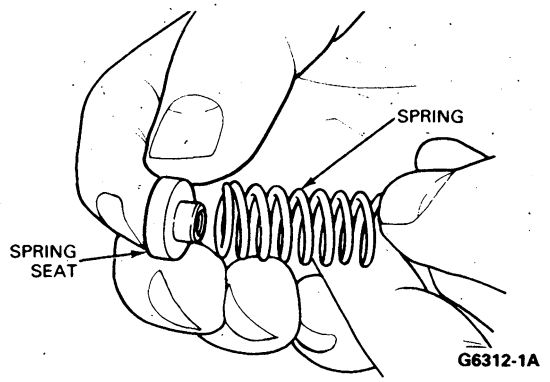
Assembly

To ensure proper operation of the power steering gear, the following procedure and its sequence should be carefully followed. Failure to do so may result in damage to the gear or faulty operation or both.

The appropriate maintenance kits should be obtained prior to reassembly.

1. Install the sealing washer around the pressure relief valve seat and using a large bladed screwdriver, or Bendix Tool 298077 install both in the valve body. Tighten the valve seat to between 20-24 N·m (15-18 ft-lbs.).
2. Install the pressure relief valve piston spring seat and spring in the valve body.

CAUTION: The spring seat must be installed as shown in illustration. Incorrect installation of the spring seat6 will result in malfunction of the relief valve and damage to the valve and seat.

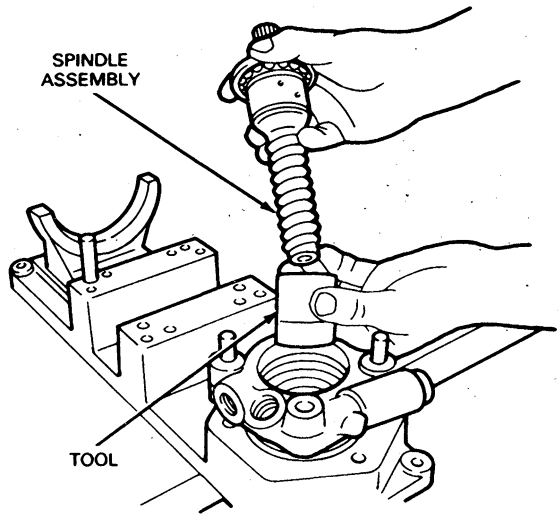


3. Install the pressure adjusting shims and the seal washer on the plug. Install the plug in the valve body and torque to 89- 99 N·m (66-73 ft-lbs) using a 26mm socket.

NOTE: When installing the pressure adjusting shims use the shims that were removed during disassembly. However, if a complete rebuild of the power steering gear is underway, it may be necessary to add or subtract shims in order to properly set the pressure relief valve.

4. Install the three O-rings and three Teflon® rings in the appropriate grooves in the valve body. Form (expand) and Teflon® rings into their grooves by 'pushing' Bendix Tool 297676, or equivalent through the bore of the valve body.

NOTE: Prelubricate the tool with a light film of lithium base grease. The spindle assembly can be used to assist in pushing the tool through the bore.



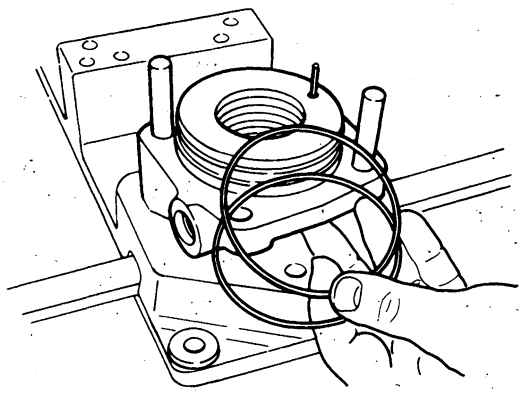
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CLEANING AND INSPECTION (Continued)

5. If the steering limiting valve was removed from the valve body, install the stem now. Apply Locktite 222 to the threads and screw the limiting stem into the valve body until a stem height of 18.7mm (0.736 inch) above the valve body surface is obtained.

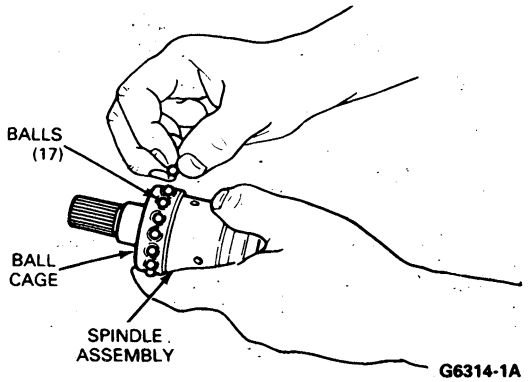
IMPORTANT: Use care in applying the Loctite compound to prevent this material from coming in contact with other surfaces of the valve body. Allow sufficient time to cure.

6. Install the O-rings on the valve body.



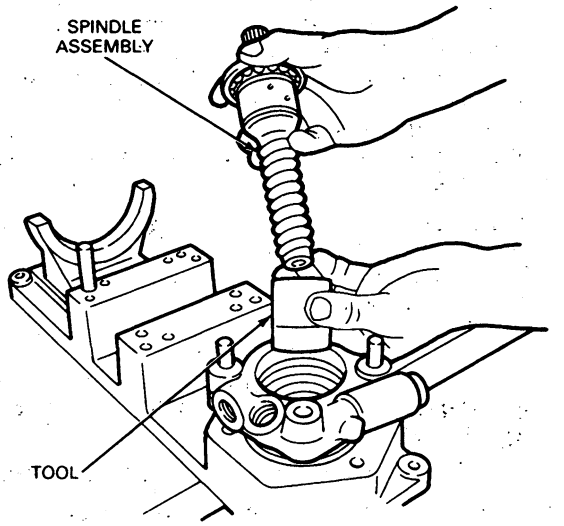
G6329-1A

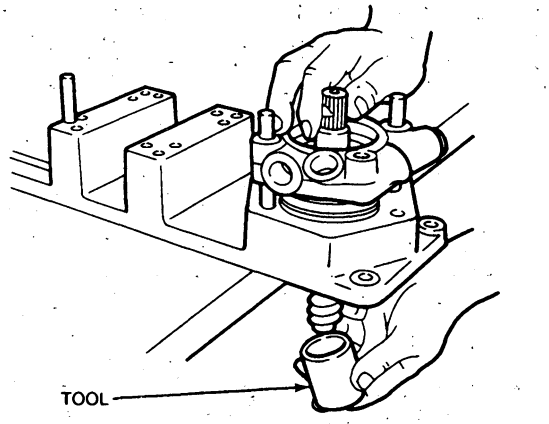
7. Install the ball cage on the input end of the spindle assembly. Using Ford Long Life Lubricant C1AZ-19590-BA, or equivalent grease to hold them in place, install the seventeen balls in the ball cage.



G6314-1A

8. Install the outer ball bearing race half over the input end of the spindle assembly and insert the spindle assembly through the ring seating tool (Bendix Tool 297676, or equivalent). Insert the spindle and tool into the valve body until tool completely exits the other side and the seventeen balls of the bearing assembly are resting against the outer race in the valve body.



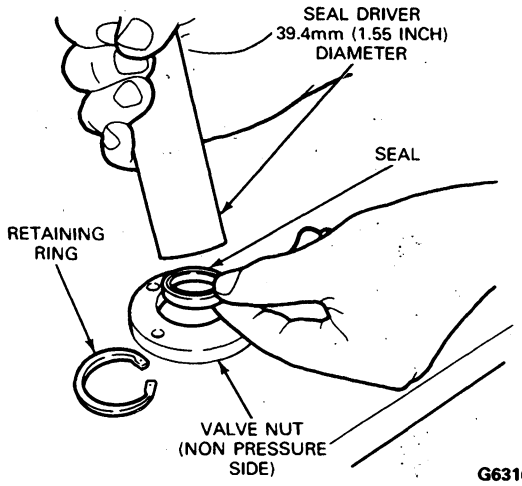


G6315-1A

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CLEANING AND INSPECTION (Continued)

9. Position the pressure side of the seal in the bore of the non-pressure side of the valve nut. Carefully drive the seal into the bore until the snap ring groove within the bore is visible. Install the retaining ring making certain it is completely seated in the groove.



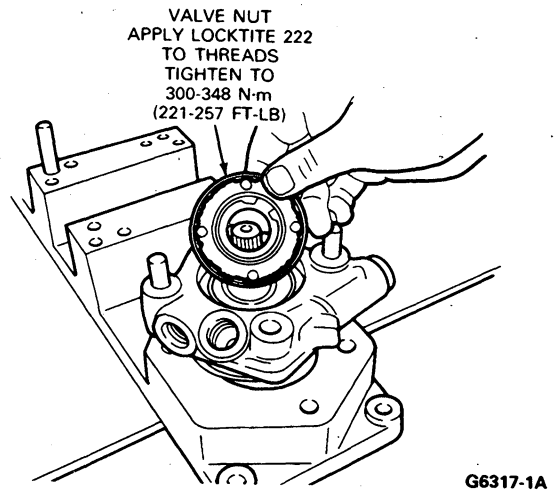
After installing the retaining ring, gently tap the seal from the opposite side until it rests squarely against the snap ring.

NOTE: The seal can be driven into the valve body bore using a piece of round brass stock with a diameter of 39.4mm (1.55 inch).

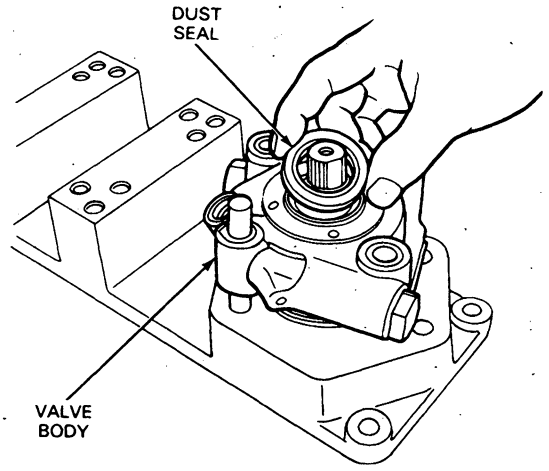
10. Apply Loctite 932 or 567 to the thread of the valve nut.

NOTE: Due to the proximity of the spindle ball bearing, use extreme care in applying the Loctite 932 or 567 to the valve nut threads. Making certain not to damage the seal install the valve nut over the input shaft end of the spindle assembly and into the valve body. Using a suitable spanner wrench such as Bendix Tool 106243. Tighten the valve nut to 300-348 N·m (221-257 ft-lbs).

Reset the safety point between the valve nut and valve body using a drift punch or similarly appropriate tool.



11. Install the dust seal in the valve nut taking care not to damage the seal.



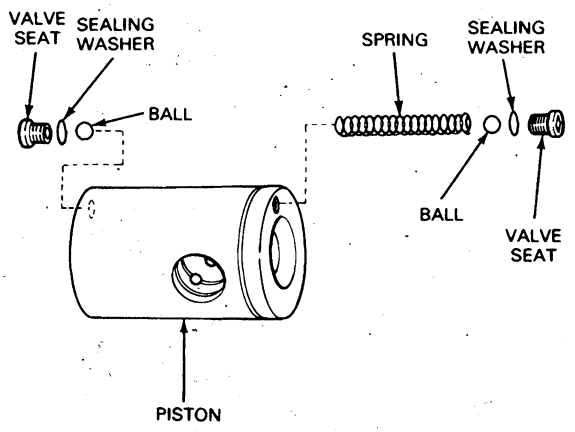
Piston

12. Install one of the two steering limiting valve seats and its sealing washer into the piston. Insert one of the two balls then the valve spring into the piston from the opposite end and install the remaining ball, sealing washer, and seat in the piston. Taking care not to damage the valve seats, torque each to 10-15 N·m (88-132 in-lbs).

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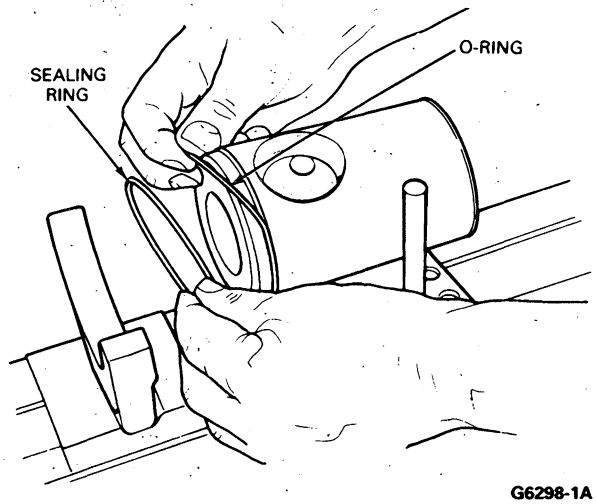
CLEANING AND INSPECTION (Continued)

NOTE: The two-piece seal may not be used in all gears. A one-piece seal is sometimes used instead.



G6299-1A

13. Install the O-ring into its groove in the piston.



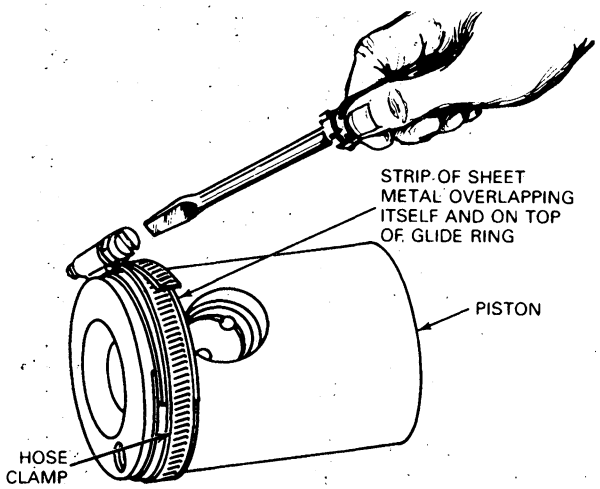
G6298-1A

14. Thoroughly heat the glide ring to 140°-160°C (285°-320°F preparation for installation on the piston.

NOTE: DO NOT USE AN OPEN FLAME to heat the glide ring. A heat lamp or a similar device should be used.

15. Install the heated glide ring over the O-ring in the piston's groove.

IMPORTANT: The glide ring should be distorted as little as possible during installation. Using an automotive piston ring compression tool or a smooth piece of sheet metal and an appropriately large screw type hose clamp, reshape the glide ring into the piston groove. Allow approximately ten minutes cooling time before removing the compression tool from the piston.



G6318-1A

16. Install the O-ring in its groove in the ball return opening of the piston.
17. Insert the valve body and spindle assembly all the way into the piston making certain that the stroke limiting stem is not damaged and that it mates with the valve seat in the piston. Insert nineteen of the balls, one at a time, into one of the recirculating tube holes in the ball return opening in the piston. Rotate the input shaft end of the spindle slightly after each ball is inserted. Rotate the spindle in one direction only and do not alternate from clockwise to counterclockwise.

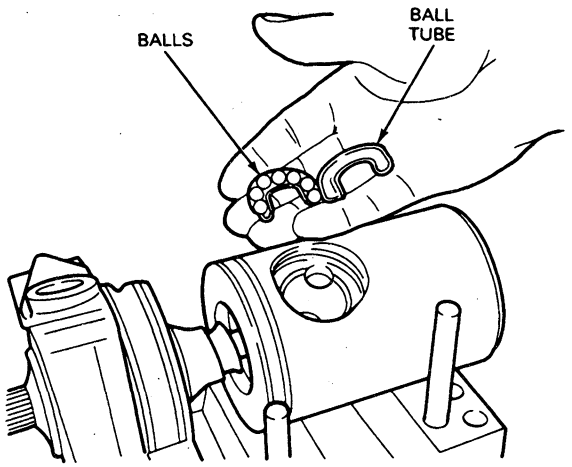
NOTE: When this operation is performed correctly, the spindle and valve body should screw out of the piston and the balls inserted in one recirculating tube hole should appear at the opposite hole. Before proceeding, make certain the balls are at an equal depth in both holes of the piston. This will assure correct installation of the return tube.

CAUTION: The utmost care must be taken with these steps. Incorrect assembly of this group may result in one or more balls falling inside the piston or coming out at the top and lodging in the housing.

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CLEANING AND INSPECTION (Continued)

18. Install the remaining seven balls in the recirculating tube halves, and use lithium base grease to retain them in the tube. Seat the assembled tube halves containing the seven balls in the recirculating tube holes in the piston.



Lightly grease the sealing surfaces of the tube cover and install it in the piston making certain the slot in the underside of the cover mates with the recirculating tube in the piston. Install the retaining ring in the piston to secure the tube cover making certain it is completely seated in its groove. After assembly, check for smooth rotation of the spindle assembly in both directions.

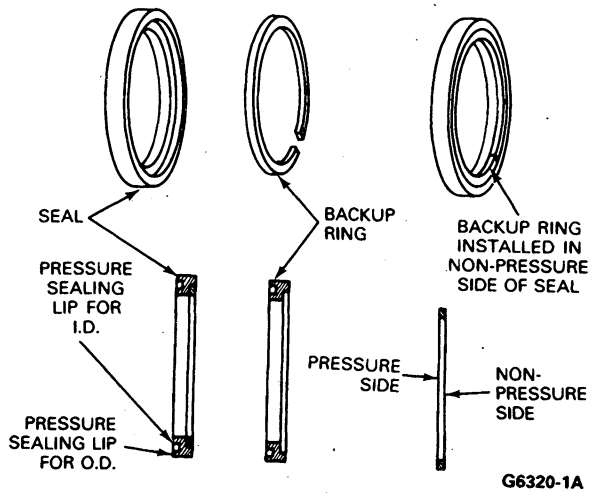
Housing

19. Reaching through the side cover opening of the housing, install the seal with its pressure side toward the INTERIOR of the housing.

NOTE: Do not distort this 'flexible' seal any more than is necessary for installation.

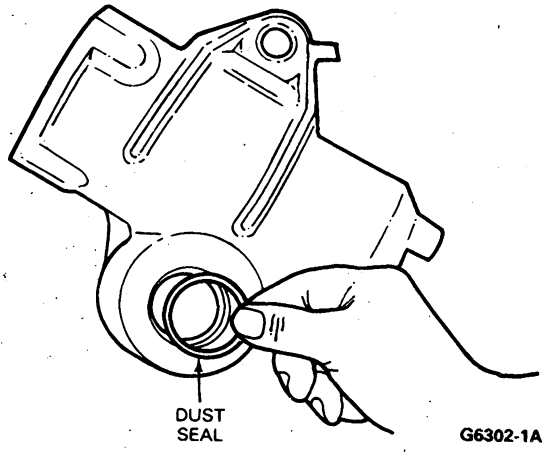
Install the split nylon backup ring, which is a separate part of the seal, in the groove formed by the backside (non- pressure side) of the seal and the housing. Make certain the split surfaces of the ring mate properly.

NOTE: This seal prevents pressurized fluid from leaking out of the housing around the output shaft.



20. Install the dust seal in the housing with its sealing lip toward the OUTSIDE of the housing.

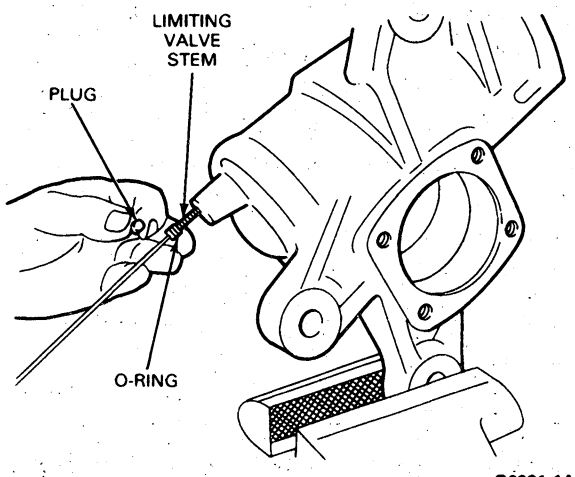
NOTE: This seal is intended to prevent water and dirt from entering the housing.



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CLEANING AND INSPECTION (Continued)

21. Install the O-ring in the groove around the steering limiting stem and screw the stem into the housing about five or six full turns.

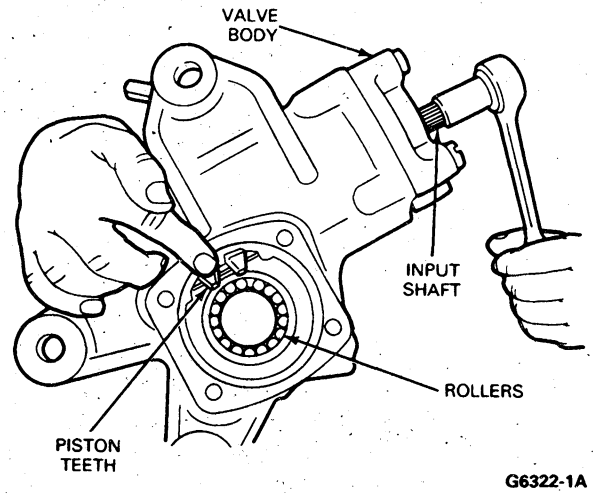


G6321-1A

22. Install the seventeen rollers of the bearing in the outer race contained in the housing. Use a heavy coating of Ford Long Life Lubricant C1AZ-19590-BA or equivalent to hold the rollers in place.

NOTE: The seventeen rollers that are installed must be the same rollers that were removed from this bearing during Disassembly.

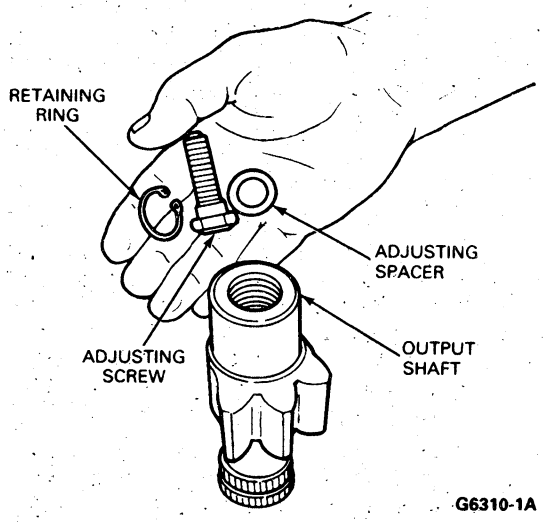
23. Align the steering limiting stem in the valve body with the steering limiting valve seat in the piston. Insert the piston into the housing so that the rack teeth of the piston are visible in the side cover opening in the housing. Make certain that the valve body is oriented in the housing so that the marks made during disassembly align. Slide the piston and valve body assembly completely into the housing taking SPECIAL CARE not to damage the piston glide ring and the valve body O-rings. Secure the valve body to the housing using four bolts. Torque the bolts to 110-119 N·m (81-88 ft-lt) using a 19mm socket and torque wrench. Rotate the input shaft of the spindle until the rack teeth of the piston are centered in the side cover opening in the housing.



G6322-1A

Output Shaft and Side Cover

24. Install the shim washer over the adjusting screw and secure both in the output shaft using the retaining ring.



G6310-1A

The maximum end play permitted for these parts is 0.050mm (0.002 inch). If end play is excessive, it may be necessary to install a different shim washer. The shim washer is available in eight different thicknesses to provide the proper end play.

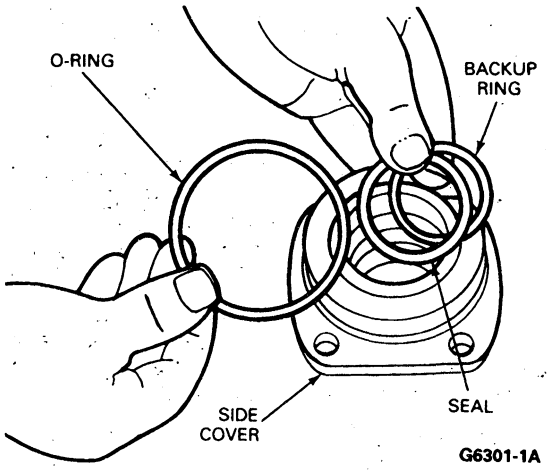
25. Install the seal in the side cover with its pressure side toward the outer race of the side cover roller bearing.

NOTE: This seal prevents fluid leakage around the output shaft. Do not distort this 'flexible' seal more than is necessary for installation.

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CLEANING AND INSPECTION (Continued)

Install the split nylon backup ring, which is a separate part of the seal, by 'winding' it into the groove formed by the side cover and the backside of the seal. Make certain the split ring is completely seated and that the diagonal split surfaces of the ring mate properly. Install the O-ring in its groove in the side cover.



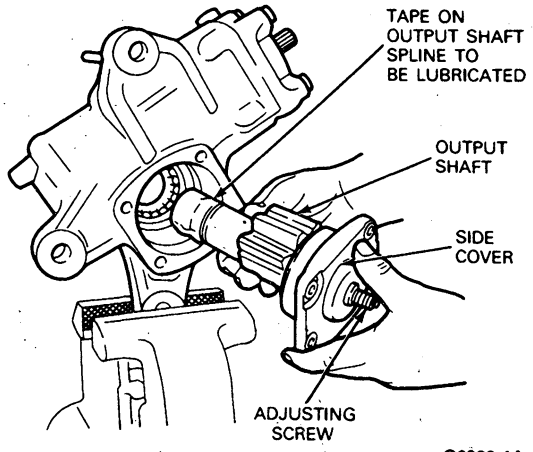
G6301-1A

26. Install the seventeen rollers of the bearing in the outer race contained in the side cover. Use a heavy coating of lithium grease to hold the rollers in place.

CAUTION: The seventeen rollers that are installed must be the same rollers that were removed from this bearing during Disassembly.

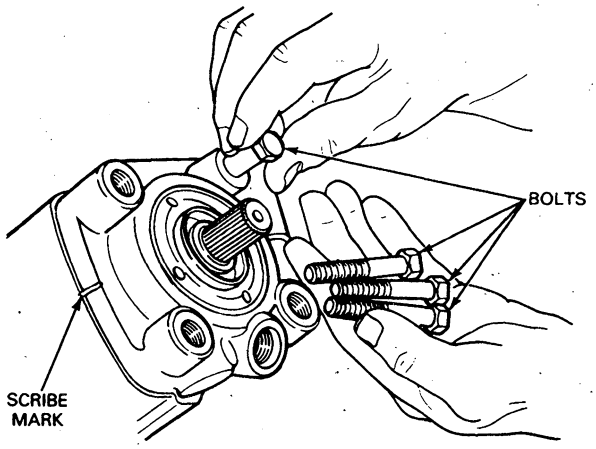
27. Lightly lubricate the seals contained in both the housing and side cover with lithium grease. Lubricate the sealing surface of the output shaft on the adjusting screw end only. Using a 7mm socket wrench install the assembled side cover on the output shaft adjuster screw and screw it on as far as it will go, then back it off 1/8 of a turn.

28. Prior to inserting the output shaft into the housing wrap a single layer of masking tape around the splines to protect the housing seal. Lubricate the exterior of the tape with a lithium grease and insert the shaft and side cover assembly into the housing with a twisting motion. Remove the masking tape from the output shaft splines.



G6323-1A

29. Secure the side cover to the housing using four bolts. Make certain that the side cover is positioned so that the marks made during disassembly are aligned. Tighten the bolts to 110-119 N·m (81-88 ft-lb) using a 19mm socket and torque wrench. Pack cavities with lithium grease then install the exterior dust boot on the output shaft and the exterior dust seal on the input shaft.



G6285-1A

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ADJUSTMENT

Adjusting the Piston to Output Shaft Gear Backlash

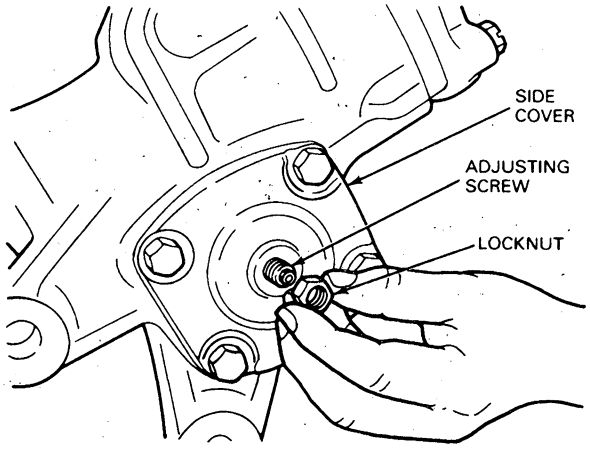
1. The piston and output shaft gear backlash is correct when a 0.50-2.0 N·m (4-18 in-lb) increase in torque is noted at the input shaft as it is rotated and the piston passes through the midpoint of its total travel in the housing. The torque increase at the input shaft will occur only as the piston travels through the mid point of its travel and should disappear as the piston moves past the midpoint.

To obtain the adjustment stated above, make certain the adjusting screw is turned counterclockwise as far as it will go. Rotate the input shaft as far as possible in both directions. Count the total revolutions in either direction and at the same time measure the average torque to rotate the shaft.

To obtain the proper backlash adjustment, rotate the input shaft 180 degrees in both directions past the midpoint of piston travel. (The midpoint of piston travel is approximately one half the number of input shaft revolutions possible in a single direction.)

Each time the direction of input shaft rotation is changed, turn the output shaft adjustment screw clockwise 1/8 to 1/4 turn. Continue this procedure until a 0.50-2.0 N·m (4-18 in-lb) increase is noted in the torque required to rotate the input shaft.

2. When the adjustment is correct, install lock nut and tighten to 100-119 N·m (74-88 ft-lbs) with a 19mm crow foot and torque wrench while holding the adjustment screw in position with the 7mm socket and torque wrench.



G6324-1A

3. After all the described steps have been performed, check that the power steering unit runs smoothly throughout its entire motion and that the backlash at the center position is as prescribed in Step 30.

4. Install the C-300N power steering gear on the vehicle. Fill gear with fluid and purge air as detailed in Section 13-01, General Steering Service. Test for flow, leakage and the pressure relief valve setting as well as setting the stroke limiting as detailed in Section 13-01 under Start-Up Procedure (After Power Steering Pump or Gear Overhaul).

Adjusting the Stroke Limiting Stem

The function of the optional steering limiting feature is to relieve most of the hydraulic power assist prior to the piston reaching the end of its full travel in either direction. This ensures that the axle stops are not impacted with full hydraulic assist when a full wheel cut is made in either direction.

The C-300N has two adjustable steering limiting stems of which only one is externally adjustable. The internal adjustable stem must be present during assembly to meet vehicle requirements.

1. Adjust the axle stops using the vehicle specifications.

2. Install a pressure gauge or gauge and flow meter combination Rotunda Power Steering System Analyzer 014-00230 or equivalent in the pressure (supply) line between the power steering pump and steering gear.

CAUTION: During the procedure that follows use extreme care not to operate the power steering pump at its relief valve pressure for more than a few seconds at a time. Extended operation at pump relief pressure will result in excessive heat and subsequent damage to the system. A thermometer installed in the pump reservoir will allow temperature checks to assure the maximum pump and gear temperatures are not exceeded.

3. Start the engine and gently turn the steering wheel to the axle stop in both directions while observing the pressure gauge and the direction of the wheel cut (right or left). This procedure should reveal which turning direction (either right or left) the externally adjustable steering limiting stem is intended to adjust. The desired reaction is described in 'A' below.

   A. In one turning direction, gauge pressure should drop substantially just prior to the steering mechanism contacting the axle stop. In the other turning direction, the gauge should register pump relief valve pressure as the steering mechanism contacts the axle stop. The turning direction that registers pump relief is the one controlled by the externally adjustable steering limiting stem.

   B. If gauge pressure does not drop prior to axle stop contact in either direction the internally adjustable steering limiting stem or valve is not functioning properly.

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ADJUSTMENT (Continued)

C. If gauge pressure drops prior to axle stop contact in both directions, turn the externally adjustable stroke limiting stem counterclockwise and repeat the test until reaction "A" is obtained.

4. Return the steering to a neutral straight ahead position and turn the externally adjustable stroke limiting stem clockwise to its full travel.

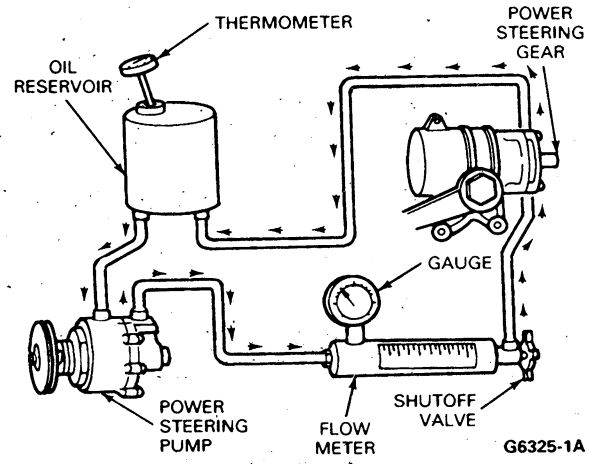
5. Gently turn the steering wheel in the direction effected by the externally adjustable stroke limiting stem until the axle stop is contacted. Pressure registered on the gauge should be relatively low. With the steering wheel held to maintain axle stop contact, turn the stroke limiting stem counterclockwise until the gauge pressure JUST begins to rise or until the gauge pressure specified by the vehicle manufacturer is obtained.

NOTE: A rise in pressure on the gauge while turning the stroke limiting stem counterclockwise indicates that the stroke limiting valve is beginning to close. Continued turning of the stem will cause the valve to close and the pressure to rise until the valve is completely closed and the pressure rises to the gear relief setting.

6. After adjustment of the stroke limiting is complete, install the plug in the stem bore in the housing.

On-Vehicle Power Steering Tests

FLOW METER AND PRESSURE GAUGE INSTALLATION



Perform the power steering pump performance tests specified in Section 13-01, General Steering Service. Make certain that system back pressure, maximum and minimum pump flow and pump relief pressure all meet specified requirements.

Testing the Power Steering Gear Pressure Relief Valve

1. To prevent the operation of the steering limiting valves, if the gear is so equipped, place a steel spacer block between the axle stop and the adjusting screw. The block should be a minimum of one inch thick and long enough to be inserted without danger of pinching fingers. Keep fingers clear of pinch points and be sure block is square to points of contact.

WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN SERIOUS INJURY OR DAMAGE TO THE EQUIPMENT.

2. Check fluid temperature in the reservoir. Thermometer reading should be approximately 54.5C (130F) at start of the test and the shut off valve on the flow meter must be totally open.

3. Turn the steering wheel until the axle stop contacts the spacer block. Apply sufficient torque to the steering wheel to ensure the power steering gear control valve is completely open in the direction of the turn. At this time the pressure gauge will read the gear pressure relief setting. If the pressure reading is 13100-14480 kPa (1900-2100 psi) the pressure relief valve is operating properly. If the pressure is outside of this range, the pressure relief valve should be adjusted or repaired as necessary.

CAUTION: When running this test, do not hold the torque on the steering wheel for more than 5 seconds beyond the time the pressure relief setting has been reached. It may damage the unit or cause the temperature of the oil to raise beyond 93°C (200°F).

Testing the Power Steering Gear for Internal Leakage

NOTE: Excessive internal leakage past seals and O-rings will generally be manifested by an increase in steering effort especially when steering quickly to the right or left. The tests that follow can be used to confirm this symptom.

Use of Valve (Test) Plug Assembly

The valve (test) plug assembly is required when the pump pressure relief setting or the steering gear internal leakage must be check. When installed in the power steering gear, the valve plug temporarily raises the setting of the gear pressure **above** that of the pump.

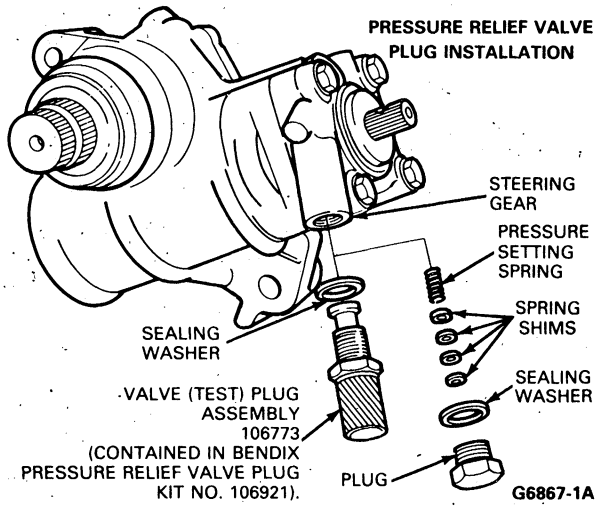
CAUTION: The vehicle should not be used in service with the valve plug installed.

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ADJUSTMENT (Continued)

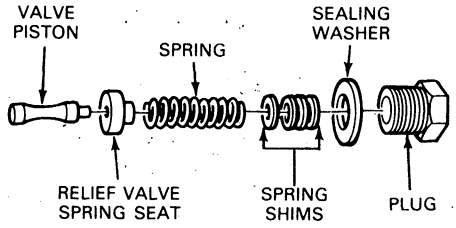
Installation of Valve (Test) Plug

1. Park the vehicle on a level surface, block the wheels and stop the engine.
2. Locate the power steering gear pressure relief valve and remove the valve plug and its sealing washer from the power steering gear.



3. Remove the spring shims and the pressure setting spring.

CAUTION: Do not remove the pressure relief valve spring seat or valve piston. If these parts are accidentally removed, reinstall them in the order shown, making certain the small diameter of the spring seat will fit inside the inside diameter of the valve (test) plug or valve spring.



PRESSURE RELIEF VALVE DETAIL

G6868-1A

4. Separate the sealing washer from the plug and reinstall the sealing washer on the valve (test) plug assembly.

   NOTE: Reusing the sealing ring on the test plug may result in some minor leakage during testing. If this is objectionable, use a **new** sealing ring on the test plug.

5. **IMPORTANT:** Install the valve (test) plug assembly into the power steering gear making certain the I. D. of the test plug fits over the spring seat. Tighten the valve (test) plug to 90-100 N·m (66-74 ft-lb).
6. After tightening the valve (test) plug, the power steering pump pressure relief valve and/or steering gear internal leakage tests may be performed.

Internal Leakage Test

1. To prevent the operation of the steering limiting valves, if the gear is so equipped, place a steel spacer block between the axle stop and the adjusting screw. The block should be a minimum of one inch thick and long enough to be inserted without danger of pinching fingers. Keep fingers clear of pinch points and be sure block is square to points of contact.

WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN SERIOUS DAMAGE TO THE EQUIPMENT.

2. Run the engine at idle. Turn the steering wheel until the axle stop contacts the spacer block. Apply a sufficient torque to the steering wheel to ensure the power steering gear control valve is completely open in the direction of the turn. Observe the following.
   A. Gauge pressure should read the same as the power steering pump relief pressure.
   B. With system pressure at pump relief, read the flow meter. If a flow greater than 3.8 Liters (1 gallon) per minute is noted, internal leakage is excessive and the steering gear requires repair.

CAUTION: When running this test, do not hold the torque on the steering wheel for more than 5 seconds beyond the time the pressure relief setting has been reached. It may damage the unit or cause the temperature of the oil to raise beyond 93°C (200°F).

3. Repeat Step 2-turning the steering wheel in the opposite direction.

NOTE: Before returning this vehicle to service, remove the pressure gauge and flow meter combination and the valve (test) plug per the following procedure:

Removal of Valve (Test) Plug

1. Remove the valve (test) plug assembly and sealing washer from the steering gear. Discard the sealing ring.
2. Install a new sealing ring on the plug. **IMPORTANT:** It is important that a new (unused) sealing ring be installed to prevent leakage.
3. Install all the adjusting shims removed during Step 3 of the Installation in the plug.
4. **IMPORTANT:** Install the spring making certain its I. D. fits over the small diameter of the spring seat as illustrated.

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ADJUSTMENT (Continued)

5. Install the assembled plug (with sealing ring and shims) in the power steering gear and tighten the plug to 90-100 N·m (66-74 ft-lb). Refer to the Caution in Step 3 of the Installation.
6. Start the engine, operate the steering and check for leakage around the plug before placing the vehicle in service.

SPECIFICATIONS

C-300N STEERING GEAR TORQUE SPECIFICATIONS

Description	N·m	Ft-Lbs
Steering Gear to Frame Rail Bolts	203-278	150-205
Intermediate Shaft to Gear Input Shaft	68-95	50-70
Pitman Arm to Gear Output Shaft Nut	299-406	220-300
Pressure Relief Valve Seat	20-24	15-18
Pressure Relief Valve Plug	89-99	66-73
Input Shaft Valve Nut	300-348	221-257
Valve Body to Housing Bolts	110-119	81-88
Side Cover Bolts	110-119	81-88
Output Shaft Adjustment Screw Lock Nut	100-119	74-88
Description	**N·m**	**In-Lbs**
Steering Limiting Valve Seats	10-15	88-132

CG6326-1A

C-300N OPERATIONAL SPECIFICATIONS

Steering Ratio (Input to Output Shaft)	21.2:1
Steering Wheel Revolutions for 90 Degree Rotation of Output Shaft	5.3
Maximum Output Shaft Rotation	75° (Power Assisted) 95° (Maximum Travel)
Maximum Output Shaft Torque with 1992 psi (140 Kg/CM) Power Assist	1985 Ft-Lb (270 mdaN)
Power Steering Fluid	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent
Maximum Working Temperature	120°C (248°F)
Maximum Peak Temperature	150°C (302°F)
Maximum Working Pressure	2050 psi (141.5 Bar)
Maximum Pressure Drop in the Return Line	43 psi (3 Bar)
Normal Flow	4.2 GPM (16 L/min)

CG6327-1B

SPECIAL SERVICE TOOLS

Number	Description
106234①	Spanner Wrench
106291①	Pressure Relief Test Plug Kit
297676①	Seal Seating Tool
Fabricate②	Seal Driver 1.55 Inch Diameter
298080①	Piloted Screw Driver
106762①	Holding Fixture
T64P-3590-F	Pitman Arm Puller

①Available from Bendix HVSD, 901 Cleveland, Elyria, Ohio 44116, attn: After Market Service Division.
②Use a suitable seal driver, or fabricate one from the information given in the text.

CG6328-1B

ROTUNDA EQUIPMENT

Model	Description
014-00230	Power Steering System Analyzer

CG6869-1A

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SECTION 13-52 Power Steering Pump—Saginaw

SUBJECT	PAGE
ADJUSTMENTS	
Drive Belt Tension	13-52-1
DESCRIPTION	13-52-1
DIAGNOSIS AND TESTING	13-52-1
DISASSEMBLY AND ASSEMBLY	
Power Steering Pump	13-52-4
REMOVAL AND INSTALLATION	
Power Steering Pump	13-52-1
Power Steering Pump Pulley	13-52-2
Rotor Shaft Seal	13-52-2
SPECIFICATIONS	13-52-7
VEHICLE APPLICATION	13-52-1

VEHICLE APPLICATION

Applies To E-150 Through E-350 vehicles with 4.9L, 5.0L, 5.8L, 7.5L and 7.3LD engines.

DESCRIPTION

The power steering pump (Fig. 1) is a constant displacement vane type providing hydraulic pressure for the steering system. The housing and internal parts of the pump are inside the reservoir so the pump parts operate submerged in oil. The reservoir is sealed against the pump housing, leaving the housing face and the shaft hub exposed. The reservoir has a filler neck with a cap.

The drive shaft is fitted with a pulley and is belt driven from the crankshaft. The rotor is loosely splined to the drive shaft and secured with a retaining ring. Ten vanes are mounted in radial slots in the rotor.

An identification label showing the pump model number is located on the outboard side of the pump reservoir.

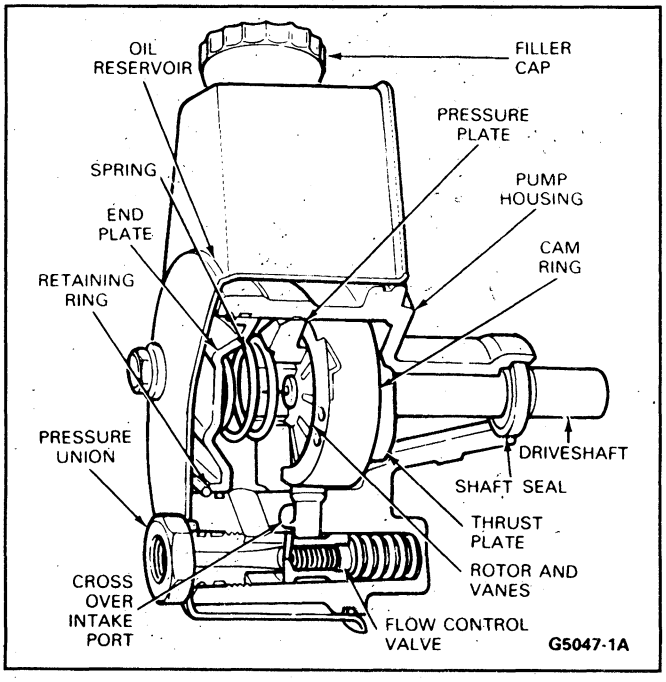


FIG. 1 Power Steering Pump—Sectional View

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service.

ADJUSTMENTS

Drive Belt Tension

For drive belt tension procedures, refer to Section 27-06, Accessory Drive Belt Service.

REMOVAL AND INSTALLATION

Power Steering Pump

Refer to Figs. 2, 3, 4 and 5.

Removal

1. Disconnect the pressure and return lines from the pump and plug them to prevent loss of fluid or entrance of dirt into the system.
2. Loosen the belt tension adjusting bolt all the way.
3. Remove the bolts attaching the pump mounting bracket to the air conditioning bracket (if equipped).
4. Remove the pump, mounting bracket, and pulley assembly.

Installation

1. Install the pump, bracket and pulley assembly and loosely attach the bolts that secure the pump mounting bracket to the air conditioning bracket (if equipped).
2. Install the drive belts on the pulley.
3. Loosely install the belt tension adjusting nut.
4. On all except the 4.9L (300 CID) and 7.3L diesel engines pry between the pump adjustment bracket and the engine block until correct tension is achieved. On 4.9L (300 CID) and 7.3L diesel engines, insert a 1/2 inch breaker bar in the adjustment slot and move the pump and bracket assembly until the specified belt tension is obtained. While still holding this tension, tighten the adjusting bolt.
5. Tighten all attaching bolts to specification. Refer to Specifications at the end of this Section.
6. Connect the pressure and return lines to the pump.
7. Fill the reservoir as described in Section 13-01 with the specified power steering fluid. Bleed the air from the system by turning the steering wheel from left to right several times. Inspect for leaks.

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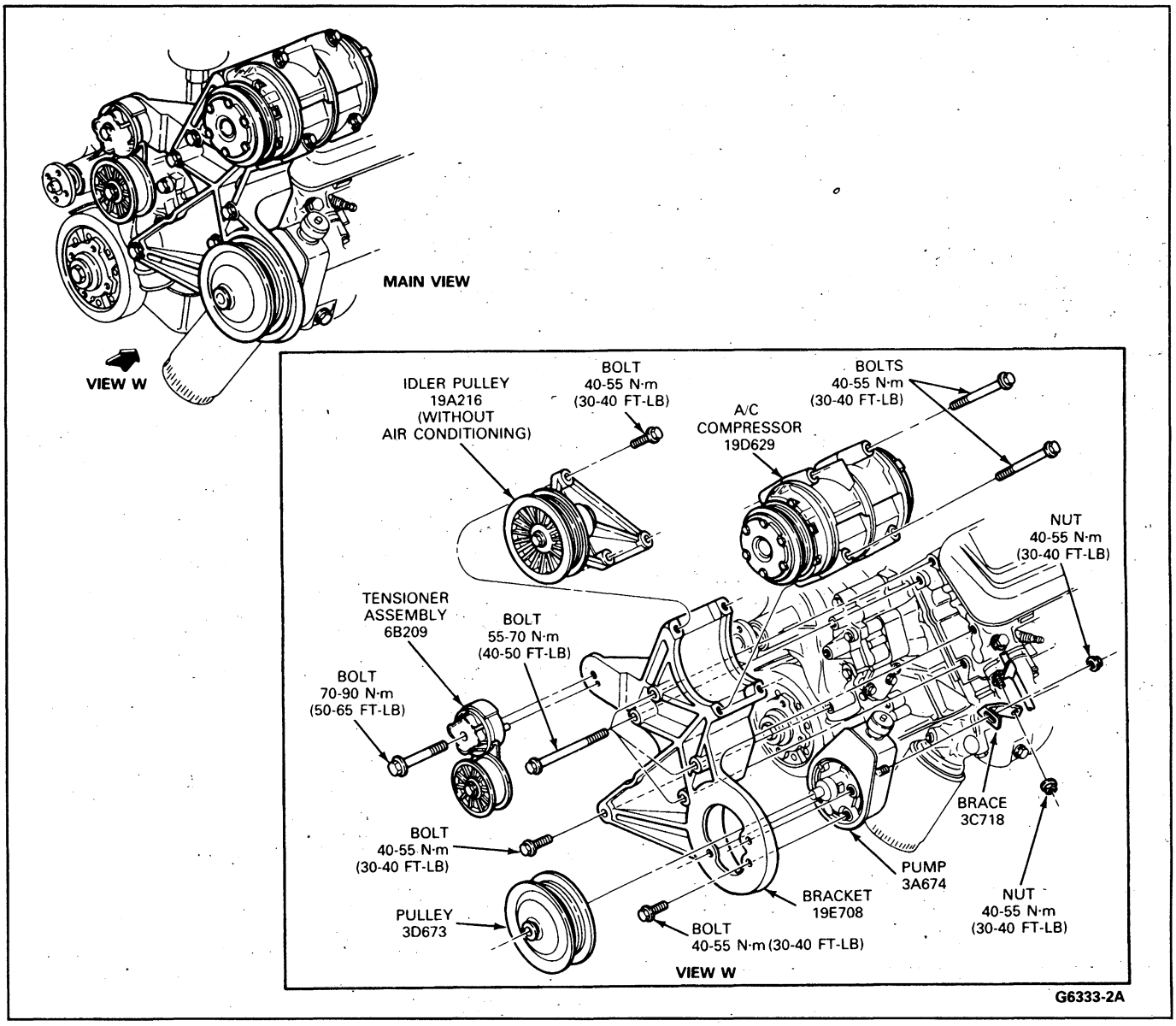


FIG. 2 Power Steering Pump Installation—7.5L EFI Engine

Power Steering Pump Pulley

Removal

1. With the pump removed from the vehicle, drain as much fluid as possible through the filler tube.
2. Clamp the mounting bracket in a vise with the pump attached. Do not clamp too tightly or bearing damage will result.
3. Install the Steering Pump Pulley Remover, T69L-10300-B or equivalent on the unit.
4. Rotate the tool nut counterclockwise to remove the pulley. If the snap ring is damaged, disassemble the pump, as outlined in this Section, and replace the ring. **Do not hammer the tool. This could damage the pulley and the snap ring at the inner end of the shaft.**

Installation

1. Install the pulley on the shaft. Front face of pulley hub must be flush within ±0.25mm (±0.010 inch) with end of pump shaft.

Rotor Shaft Seal

Remove the pump as outlined in this Section to replace the rotor shaft seal.

Removal

1. Drain as much fluid as possible through the filler tube.
2. Remove the pulley from the pump following the procedures described in this Section.
3. Insert a sharp tool between the rotor shaft seal and the pump housing. Pry out the seal. **Do not pry against the shaft or housing bore.**

Installation

1. Remove the pump and bracket from the vise and lay it flat on the workbench.
2. Place a new rotor shaft seal on the shaft with the metal backing facing the pulley end of the shaft (Fig. 6).

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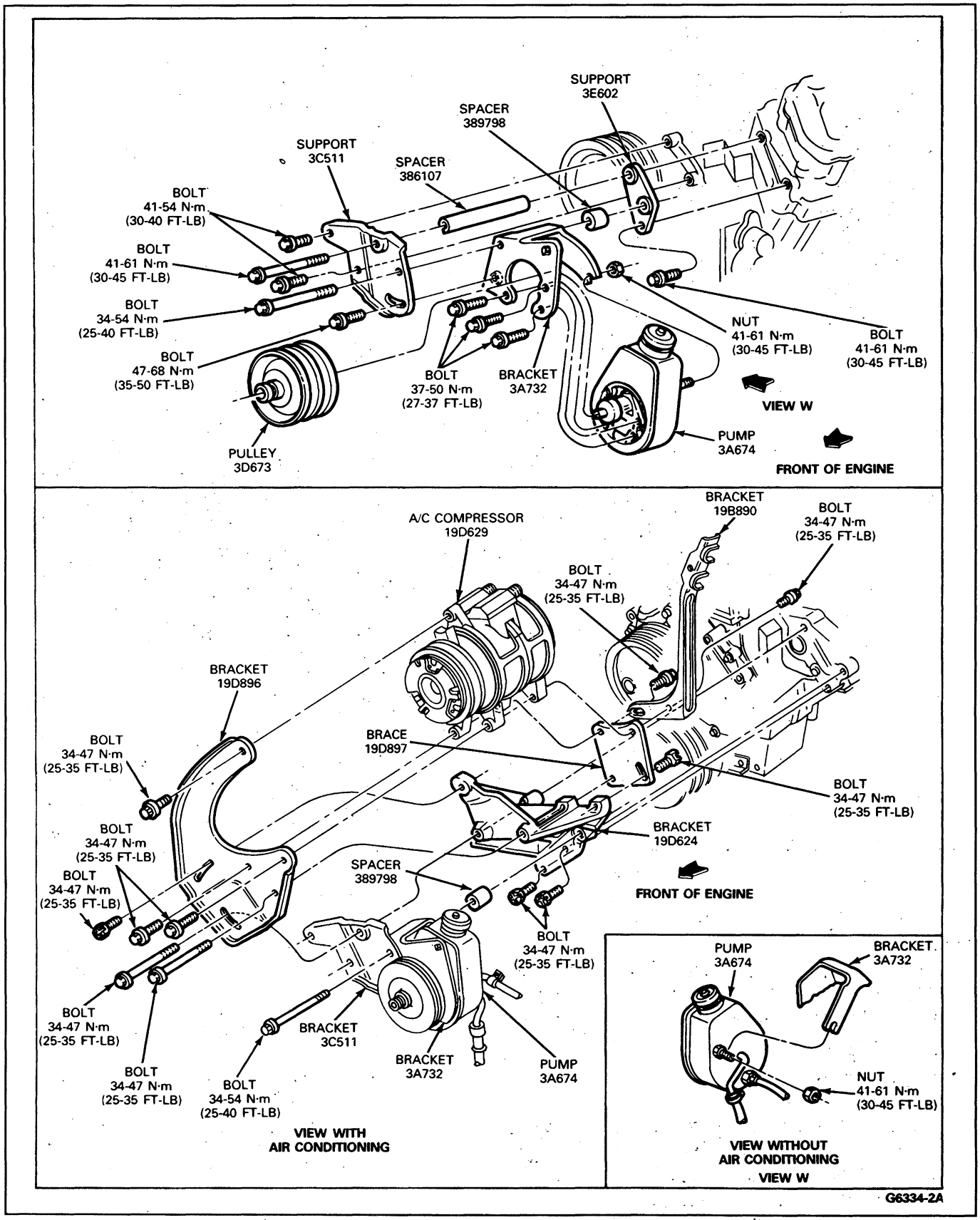


FIG. 3 Power Steering Pump Installation—7.3L Diesel Engine

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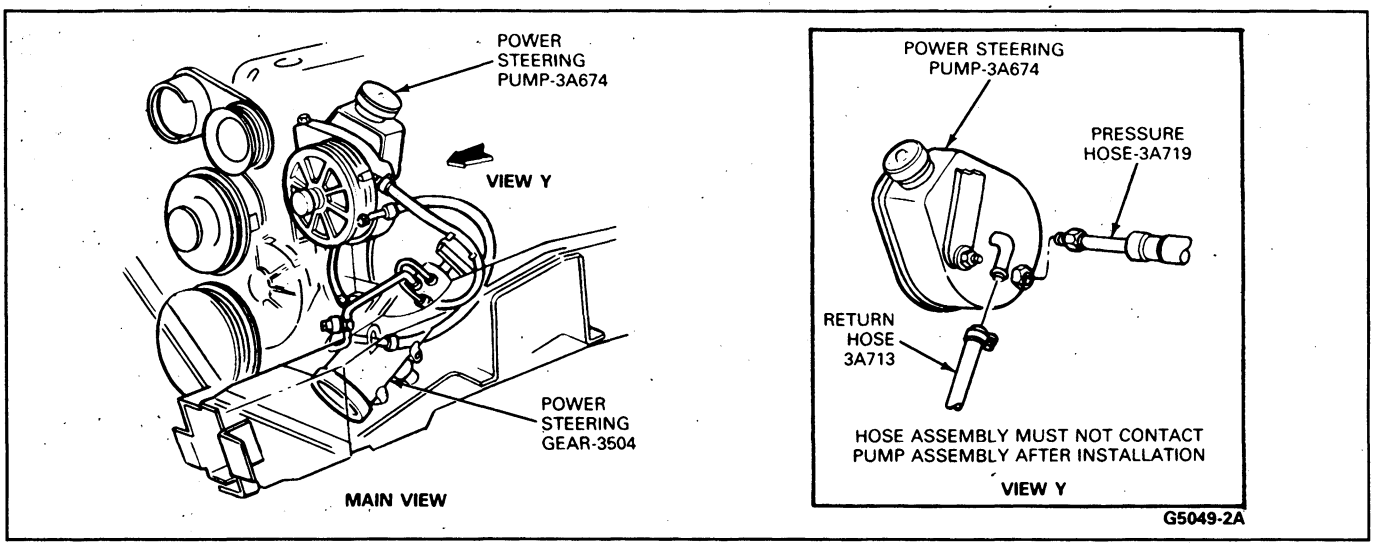


FIG. 4 Power Steering Pump Installation—4.9L EFI Gasoline Engine

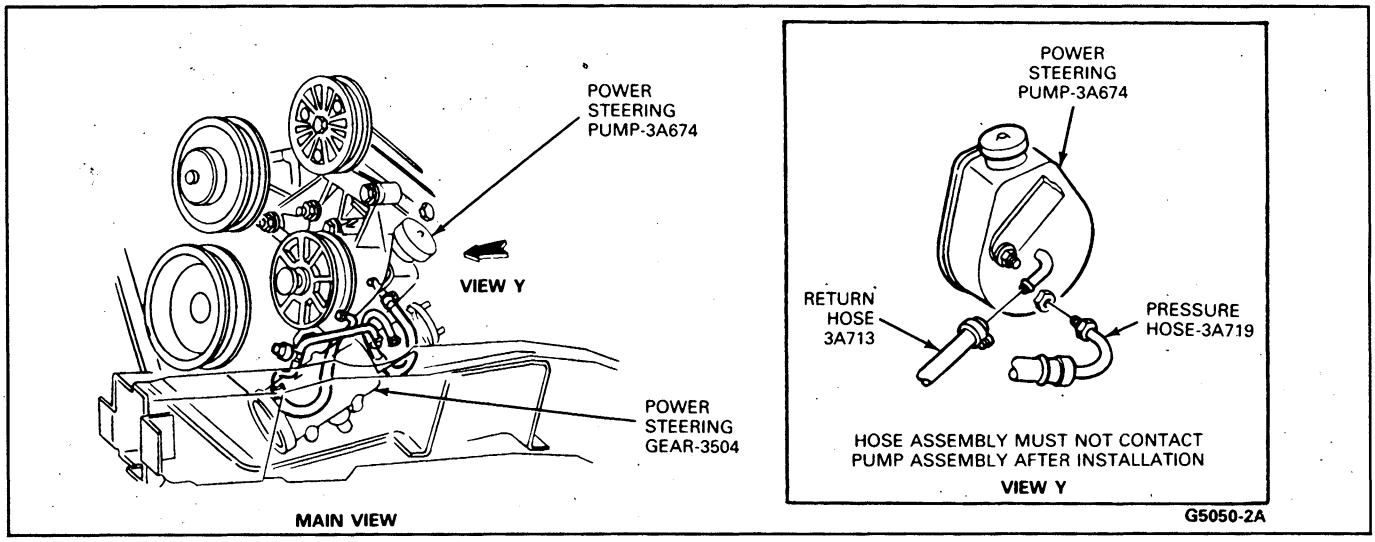


FIG. 5 Power Steering Pump Installation—5.0L and 5.8L EFI Gasoline Engine

3. Install the seal (Fig. 6) using an appropriate shaft seal installer. Tap the tool lightly with a small hammer until the seal is properly seated in the shaft hub.
4. Install the pulley.

DISASSEMBLY AND ASSEMBLY

Take the following precautions when servicing the power steering pump:

1. **Use a clean work bench and tools.**
2. Clean the exterior of the unit with solvent. Drain as much fluid as possible.
3. If only the rotor shaft seal is being replaced, follow the procedures under Rotor Shaft Seal Removal and Installation in this Section.
4. **Do not use solvent on seals.**

Power Steering Pump

Disassembly

Refer to Fig. 7.

1. Remove the bracket and pulley from the pump as described in this Section under Removal and Installation (Figs. 2-5).
2. Clamp the front hub of the pump in a vise so the extending portion of the shaft points down. **Do not clamp the pump too tightly or bearing damage may result.**
3. Remove the pressure union, O-ring assembly, and both mounting bolts from the back of the reservoir. Discard all seals and O-rings.
4. Rock the reservoir slightly back and forth to unseat the O-ring seal. Remove the O-ring and discard. Remove the reservoir.
5. Remove the mounting bolt and pressure union seals from the counterbored spaces in the pump housing. Discard the seals.
6. Rotate the end plate retaining ring so that one end of the ring is over the hole in the housing. Insert a small punch in the 1/8 inch diameter hole in the housing side opposite the flow control valve hole. Compress the retaining ring with the punch and

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remove the ring by twisting a screwdriver under the ring (Fig. 8).

7. Remove the end plate. The end plate is spring loaded and will generally sit above the housing level for easy removal. If the plate sticks, rock it back and forth lightly to free it.

8. Remove the pressure plate spring.

9. Remove the pump from the vise and turn it over allowing the flow control valve and its spring to fall out. Do not disassemble the flow control valve. Service it as a unit.

10. With the end plate O-ring removed, tap very lightly on the end of the shaft until the pressure plate falls free.

11. Remove the cam ring, vanes and rotor (Fig. 9).

12. Remove the cam ring and vanes from the rotor.

13. Remove the retaining ring by clamping the shaft in a soft-jawed vise and prying the ring off the shaft with a pair of long nose pliers or a screwdriver. Do not damage the shaft with the vise jaws. Discard the retaining ring.

14. Remove the thrust plate from the shaft.

15. Remove both dowel pins from the housing.

16. Remove the pressure plate and end plate O-ring seals from the housing bore and discard them.

17. Remove the shaft seal only if it is worn or damaged. Removal will destroy the seal.

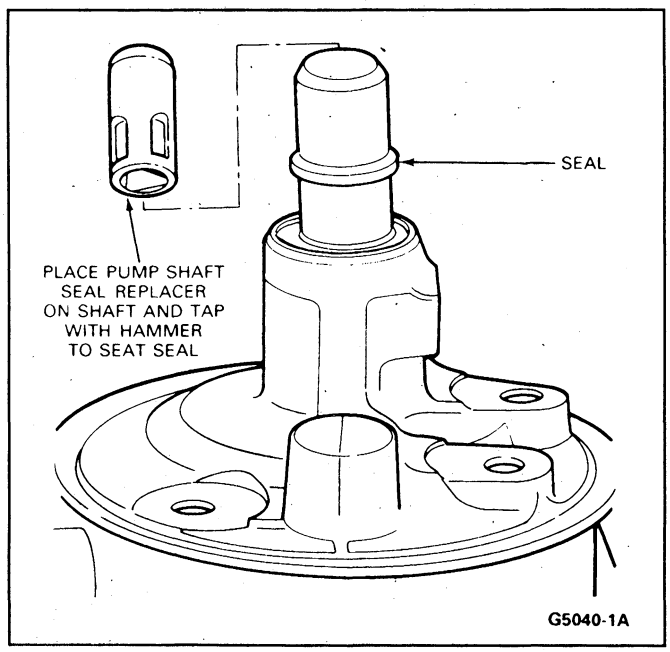


FIG. 6 Installing the Rotor Shaft Seal

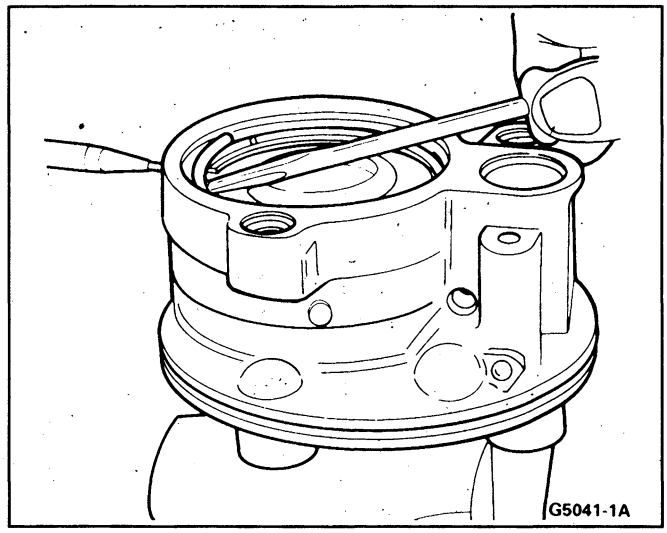


FIG. 8 Removing the End Plate Retaining Ring

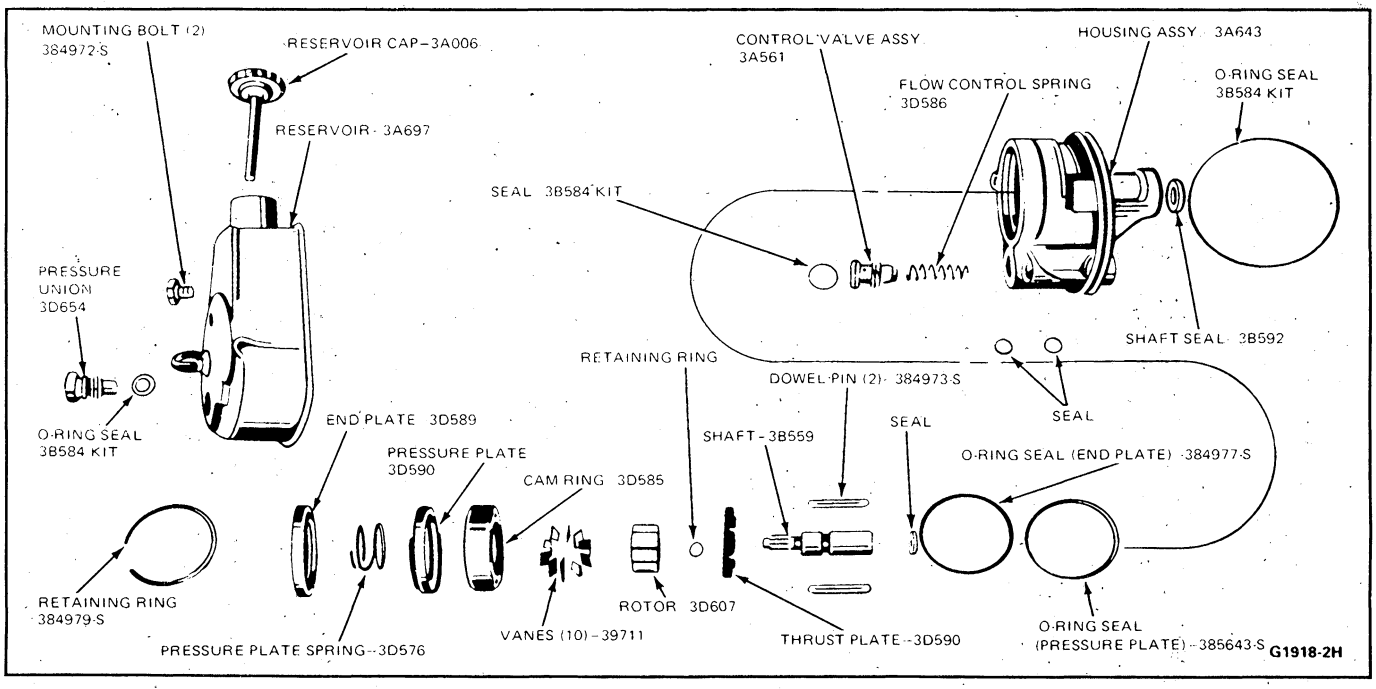


FIG. 7 Power Steering Pump Disassembled

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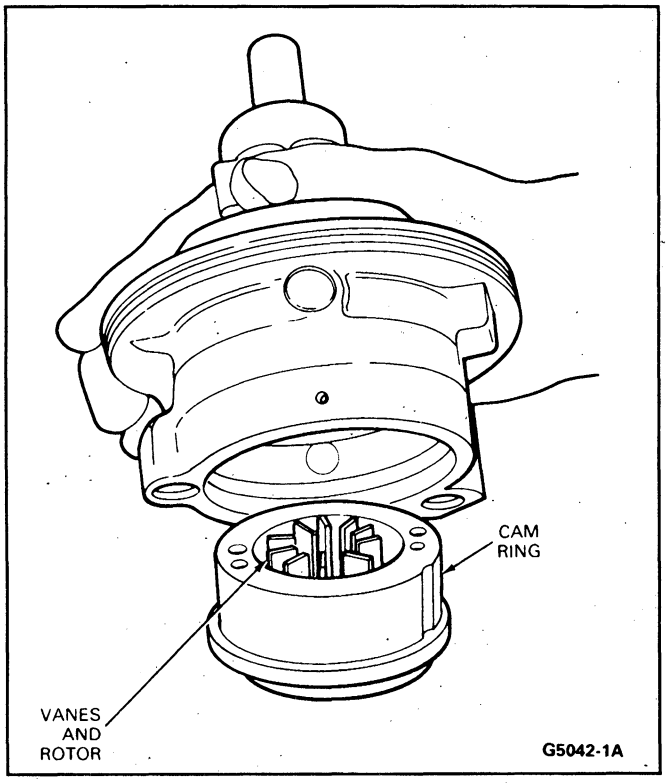


FIG. 9 Removing The Cam Ring, Vanes And Rotor

Assembly

1. Clean all metal parts with solvent.
2. If the shaft seal was removed, install a new seal following the instructions under Rotor Shaft Seal Removal and Installation in this Section.
3. Lubricate a new pressure plate O-ring seal with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent and install it in the third groove from the rear of the housing.
4. Clamp the end hub of the housing in a vise so the extending portion of the shaft points down. Do not clamp the bearing too tightly or damage may occur.
5. Insert both dowel pins.
6. Install the thrust plate on the shaft with the ports toward the splined end of the shaft.
7. Install the rotor on the shaft with the counterbored end toward the thrust plate.
8. Clamp the shaft in a soft-jawed vise. Install a new retaining ring on the splined end of the shaft by prying the ring open and sliding it down over the shaft until it seats in the ring groove. Use the round wire ring from the retaining ring service kit. **Do not damage the shaft.**
9. Insert the shaft in the housing. Lubricate shaft with power steering fluid, and make certain the thrust plate slides properly on the dowel pins.
10. Install the cam ring on the dowel pins with the rotation arrow toward the rear of the housing (Fig. 10).
11. Install the vanes in the rotor slots with the rounded edge of the vanes outward. Be sure the vanes slide freely (Fig. 11).

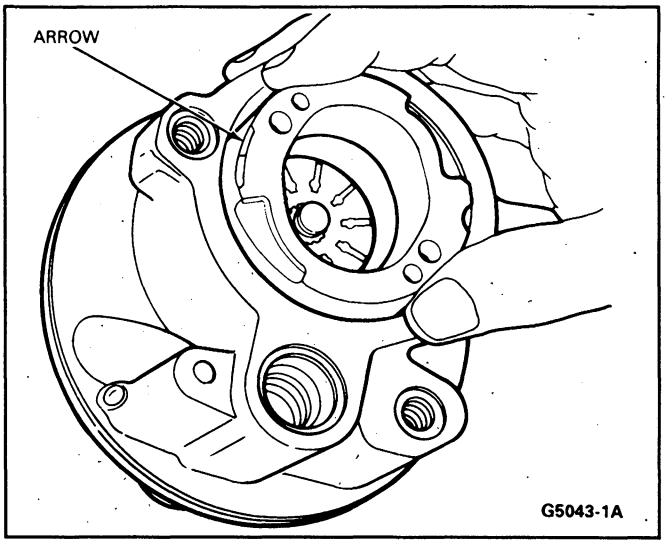


FIG. 10 Installing the Cam Ring

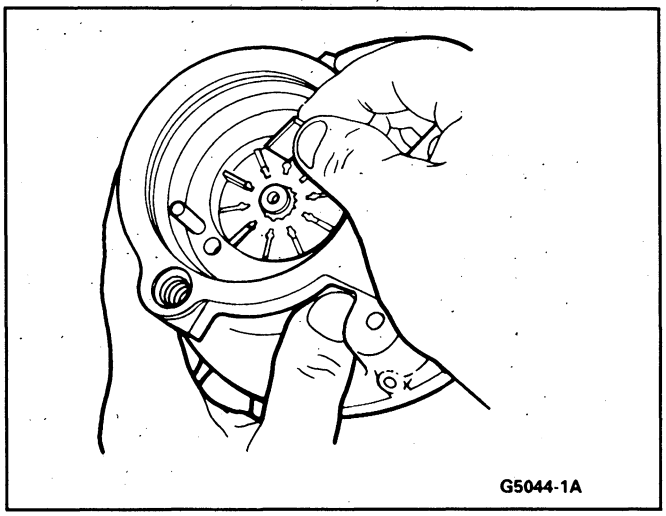


FIG. 11 Installing the Vanes in the Rotor

12. Lubricate the pressure plate with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent to prevent damage to the pressure plate O-ring seal.
13. Install the pressure plate on the dowel pins with the circular spring depression toward the rear of the housing (Fig. 12). The narrow slots in the plate should engage the dowel pins. To seat pressure plate, press it about 1.19mm (1/16 inch) over the O-ring.
14. Lubricate a new end plate O-ring with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent and install it in the second groove from the rear of the housing.
15. Install the pressure plate spring in the groove in the pressure plate.
16. Lubricate the end plate with power steering fluid to prevent damage to the O-ring, and press it into the housing with an arbor press (Fig. 13). Depress the end plate only far enough to allow installation of the retaining ring in its groove.
17. Install the end plate retaining ring. Release the arbor press.

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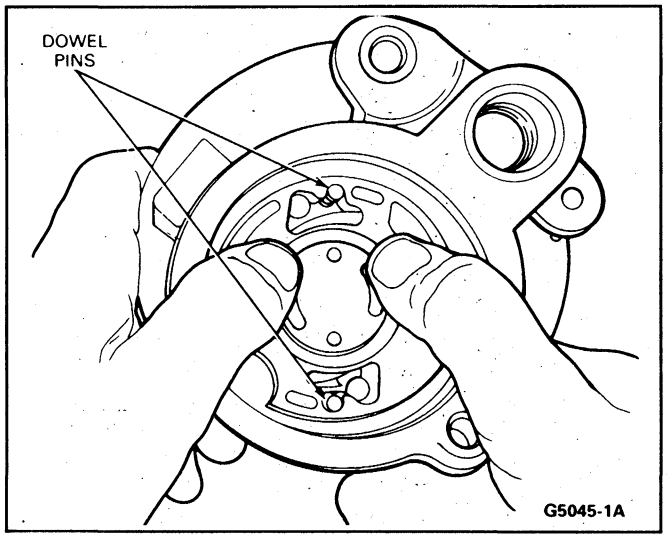


FIG. 12 Installing the Pressure Plate

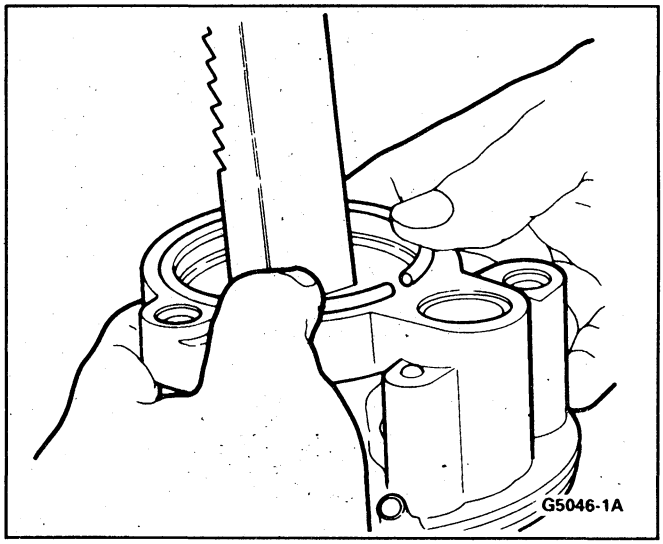


FIG. 13 Installing the End Plate Retaining Ring

18. Place the control valve spring in its hole and insert the control valve with the screened end towards the front of the housing.
19. Install new mounting bolt and pressure union seals in the countersunk holes. Lubricate a new reservoir O-ring seal with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent, and install it on the housing.
20. Lubricate the inside edge of the reservoir with power steering fluid and install it on the housing. Align the holes in the reservoir and housing. Replacement reservoirs do not have an identification number. If a new reservoir is installed, imprint the model number of the worn or damaged reservoir on the new part for future identification.
21. Insert the mounting bolt and tighten to 47 N·m (35 ft-lbs).
22. Lubricate a new O-ring with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent and install it on the pressure union in the groove next to the head hex. Insert the pressure union in the flow control valve hole in the back of the reservoir and tighten to specification listed at the end of this Section.

SPECIFICATIONS

SAGINAW POWER STEERING PUMP TORQUE LIMITS — ALL EXCEPT 7.3L DIESEL ENGINE

Description	Size	Engine				Torque	
		4.9L (300 CID) I-6	5.0L (302 CID) V-8	5.8L (351 CID) V-8	7.5L (460 CID) V-8	N-m	Ft. Lbs.
Support bracket to engine bolt	3/8-16 x .75		X	X	X	48-60	30-45
	5/16-18 x 1.25	X				30-43	22-32
	7/16-14 x 1.25	X				55-81	40-60
Adjusting bolt	7/16-14 x .75		X	X	X	57-77	42/57
	3/8-16 x .75	X				40-60	30-45
Pump to adjusting bracket bolt	10mm x 19mm	X	X	X	X	40-60	30-45
Support bracket to adjusting bracket to engine bolt	7/16-14 x 6.00		X	X	X	57-77	42-57
Support bracket to adjusting bracket bolt	3/8-16 x .75	X				40-60	30-45
Pump to adjusting bracket nut	M-10		X	X	X	40-60	30-45
Pressure line to pump nut	—	X	X	X	X	15-25	20-35
Pressure line to gear nut	—	X	X	X	X	15-22	20-30
Return line to gear nut	—	X	X	X	X	15-22	20-30

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SAGINAW POWER STEERING PUMP TORQUE LIMITS — 7.3L DIESEL ENGINE

Description	Size	Torque	
		N·m	Ft-Lbs
Support Bracket to Engine Bolt	3/8-16 x .88	41-61	30-45
	3/8-16 x 6.0	41-61	30-45
Support Bracket to Adjusting Bracket	7/16-14 x 6.12	34-61	25-40
Adjusting Bracket to Pump	M10-1.5 x 18	37-50	28-36
Adjusting Bolt	7/16-14 x 1.0	48-67	35-50
Pressure and Return Line to Gear	—	34-40	25-30
Pressure and Return Line to Pump	—	34-40	25-30

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DRIVE BELT TENSION

Belt Width	Minimum Tension (for use at maintenance interval only) (Hot Engine)		Installation Tension			
			Used Belt 1		New Belt	
	Lbs	N	Lbs	N	Lbs	N
1/4"	30	133	60	267	80	356
3/8" and 15/32"	50	222	110	489	140	623
1/2"	50	222	110	489	140	623

1 Any belt operated for 10 minutes or more is considered a used belt.

CY2473-2A

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T57L-500-B	Bench Mounted Holding Fixture	Universal
TOOL-1175-AC	Seal Remover	Universal — Use with Slide Hammer
D79L-7000-A	Retaining Ring Pliers	Internal and External Retaining Rings
T63L-8620-A	Belt Tension Gauge	Universal
T69L-10300-B	Steering Pump Pulley Remover	Pump Removal
T71P-19703-C	O-Ring Tool	Universal
T68L-33610-AB	Thermometer	Use with Power Steering Analyzer
D79L-33610-A	Power Steering Analyzer	All Vehicles

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SECTION 13-53 Power Steering Pump—C-II

SUBJECT	PAGE
ADJUSTMENTS	
Pump Belt Tension Adjustment	13-53-1
DESCRIPTION	13-53-1
DIAGNOSIS AND TESTING	13-53-1
DISASSEMBLY AND ASSEMBLY	
Power Steering Pump	13-53-4
REMOVAL AND INSTALLATION	
Power Steering Pump	13-53-2
Power Steering Pump Drive Belt Installation and/or Adjustment (Slider Type)	13-53-3
REMOVAL AND INSTALLATION (Cont'd)	
Power Steering Pump Drive Belt Replacement (Pivot Type)	13-53-3
Power Steering Pump Pulley	13-53-2
Power Steering Pump Reservoir	13-53-4
Quick Connect Power Steering Fitting Service	13-53-2
Rotor Shaft Seal	13-53-3
SPECIFICATIONS	13-53-14
VEHICLE APPLICATION	13-53-1

VEHICLE APPLICATION

All Bronco and F-150 through F-350 and F-Super Duty Vehicles.

DESCRIPTION

The C-II power steering pump is used in all F-150—F-F-Super Duty light trucks and Bronco (Fig. 1).

The C-II power steering pump is a belt driven slipper type pump with a fiberglass reinforced nylon reservoir. The reservoir is attached to the rear side of the pump housing front plate and the pump body is encased within the housing and reservoir. The pressure hose is attached with a quick connect fitting, located below the filler neck at the outboard side of the reservoir, and the fitting allows the line to swivel. This is normal and does not indicate an untorqued fitting.

A pressure sensitive identification tag will be attached to the reservoir. The top line of this tag indicates the basic model number (HBC) and the suffix. Always use these tags when requesting service parts as there may be slight differences in internal components.

DIAGNOSIS AND TESTING

For problem diagnosis refer to Section 13-01, General Steering Service.

ADJUSTMENTS

Pump Belt Tension Adjustment

For the proper belt tensioning sequence, refer to Section 27-06, Accessory Drive Belt Service.

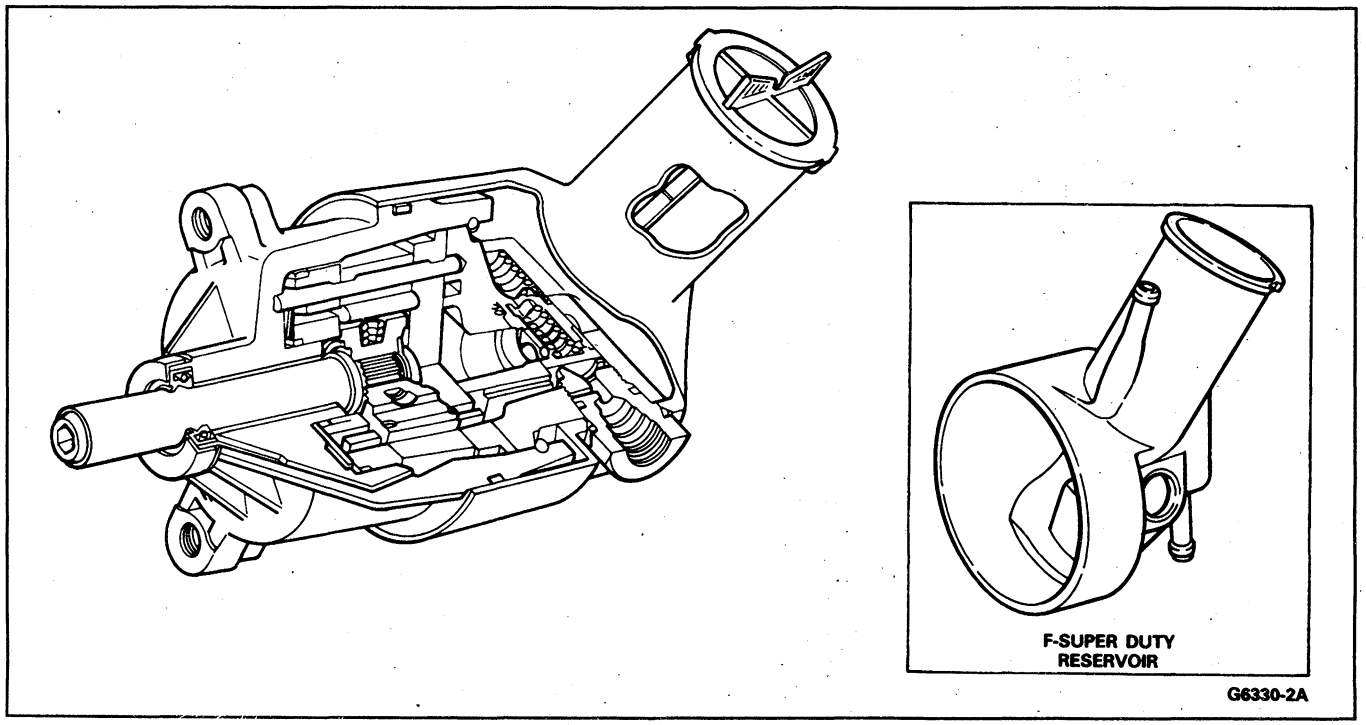


FIG. 1 Ford Model C-II Power Steering Pump—Sectional View

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REMOVAL AND INSTALLATION

Quick Connect Power Steering Fitting Service

The quick connect power steering fitting, under certain conditions may leak and/or result in improper engagement. The leak can be caused by a cut O-ring, imperfections in the outlet fitting inside diameter, or improperly machined O-ring groove. Improper engagement can be caused by an improperly machined tube end, tube nut, snap ring, outlet fitting, or gear port.

If a leak occurs, the O-ring should be replaced with quick connect O-rings (3/8 tube end: 388749-S; 5/16 tube end: 388748-S). The O-rings that are used on the tube-O power steering fitting should not be used on the quick connect fitting because of dimensional and material changes. If O-ring replacement does not solve the leak problem, outlet fitting replacement and, lastly, hose replacement should be made.

If improper engagement occurs due to a missing or bent snap ring, or improperly machined tube nut, it may be repaired with a service snap ring kit (kit includes a new tube nut). The system should then be properly filled, the engine started, and the steering wheel cycled from lock-to-lock to test for positive engagement. If the hose assembly still does not engage, replace the entire hose assembly.

Quick connect hose assemblies for service have tube nuts, snap rings, and O-rings already attached. (Fig. 2).

When the quick connect tube nut is tightened or loosened, a tube nut wrench, not an open end wrench, is recommended. An open end wrench may result in tube nut deformation under excessive torque conditions. Care must be taken not to overtighten the tube nut. Tighten to 14-20 N·m (10-15 ft-lbs). Swivel and/or end play of the quick connect fittings is normal, and does not indicate an undertightened fitting.

Power Steering Pump Pulley

Removal

1. Drain as much fluid as possible from the pump through the filler pipe.

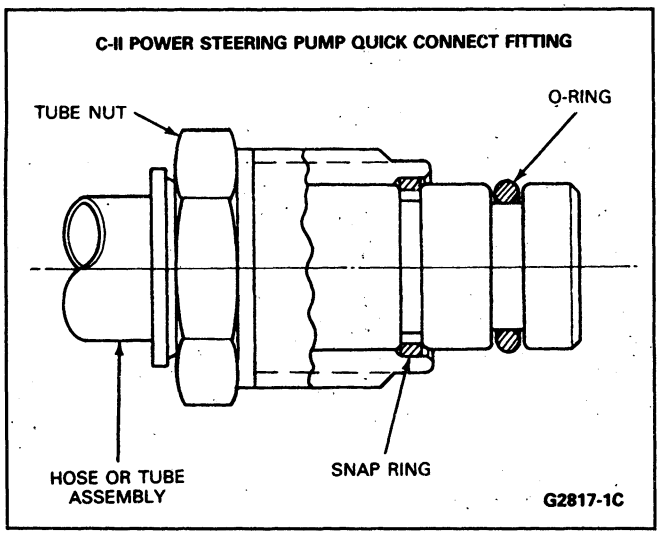


FIG. 2 Quick Connect Fittings

2. Install pulley remover Tool T69L-10300-B or equivalent on the pulley hub, placing the tool and pump in a vise (Fig. 3).
3. Hold the pump and rotate the tool nut counter-clockwise to remove the pulley. Do not apply in and out pressure on the pump shaft. Pressure will damage the internal thrust areas.

Installation

1. Attach pump to adjustment bracket. Place the pulley on the pump shaft and install Tool T65P-3A733-C or equivalent (Fig. 3).

   Hold the pump and rotate the tool nut clockwise to install the pulley on the shaft. The pulley hub face must be flush within ±0.25mm (±0.010 in.) of the end of the pump shaft. Do not apply in and out pressure on the shaft. Pressure will damage the internal pump areas.
2. Remove the tool.

Power Steering Pump

Removal

Refer to Figs. 4-8.

1. To remove the power steering fluid from the pump reservoir, disconnect the fluid return hose at the reservoir and drain the fluid into a container.
2. Remove the pressure hose from the pump.
3. Remove the bolts and nuts from the pump adjustment bracket. Loosen the pump sufficiently to remove the belt off the pulley. Remove the pump (still attached to the adjustment bracket) from the support bracket.
4. Remove the pulley from the pump as described in this Section.
5. Remove the bolts attaching the adjustment bracket to the pump and remove the pump.
6. On 4.9L and 5.0L engines with serpentine drive belt, remove the drive belt by lifting the belt tensioner out of position.

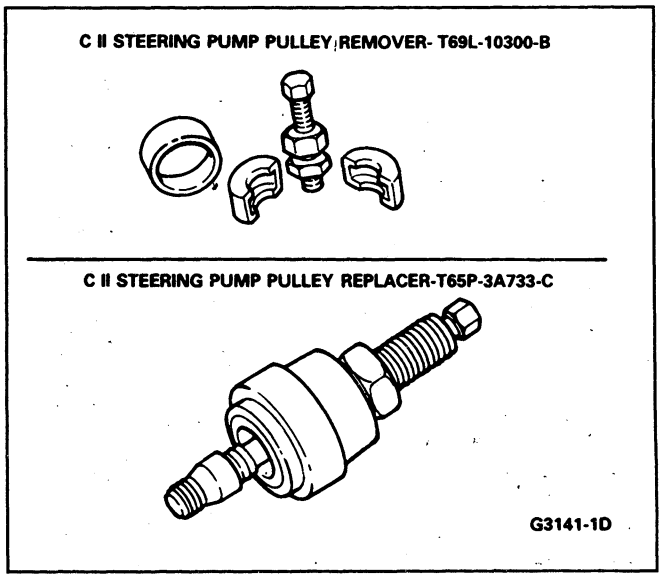


FIG. 3 Pulley Removal and Installation Tools—35.05mm (1 3/8 Inch) Hub Diameter

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7. Remove the pulley from the pump as described in this Section.
8. Remove the bolts attaching the pump to the bracket and remove the pump.

Installation

1. Place the adjustment bracket on the pump. Install and tighten the bolts to specification listed at the end of this Section.
2. On 4.9L and 5.0L engines install the bolts and attach pump to bracket.
3. Install the pulley on the pump as described in this Section.
4. Place the pump with adjustment bracket and pulley on the support bracket. Install the bolts and nuts connecting the support bracket to the adjustment bracket and tighten to specifications.
5. Place the belt on the pulley and adjust belt tension as described in this Section. Tighten bolts on adjustment bracket to specifications. On 4.9L and 5.0L engines, install the serpentine drive belt in position on all pulleys and release the belt tension so that drive belt is tight.
6. Install the pressure hose to the pump fitting.
7. Connect the return hose to the pump, and tighten the clamp.
8. Fill the reservoir with specified power steering fluid, start the engine and turn the steering wheel from stop to stop to remove air from the system.
9. Check for leaks and recheck the fluid level. Add fluid if necessary.

Power Steering Pump Drive Belt Replacement (Pivot Type)

1. On vehicles with air conditioning, loosen the idler pulley attaching bolts and remove the compressor drive belt.
2. Loosen adjusting and pivot bolts attaching the power steering pump adjustment bracket to the pump support bracket, and remove the pump drive belt.
3. Position the new power steering pump drive belt on the pulleys.
4. Adjust the drive belt tension to specifications as outlined in this Section.
5. On vehicles with air conditioning, install the compressor drive belt, and adjust to specifications (refer to Specifications in Section 13-01, General Steering Service).

Power Steering Pump Drive Belt Installation and/or Adjustment (Slider Type)

1. Loosen the bolts so the adjustable bracket is free to slide inboard on the stationary bracket.
2. Loosen the belt adjustment bolt enough to move the pump assembly and adjustable bracket inboard. Remove the belt.
3. If installing a new belt, place it on the proper pulleys.
4. Tighten the adjustment bolt until snug.
5. Install a Belt Tension Gauge, T63L-8620-A or equivalent, and tighten the belt adjustment nut until the proper tension is attained 533-667 N (120 to 150 lbs) for a new belt, 400-533 N (90-120 lbs) for a used belt.
6. Tighten the nuts on the vertical studs to 41-54 N·m (30-40 ft.-lb.).
7. Remove the tension gauge.

Rotor Shaft Seal

Replacement of the rotor shaft seal requires pump disassembly. Refer to the Disassembly and Assembly procedures in this Section for seal replacement.

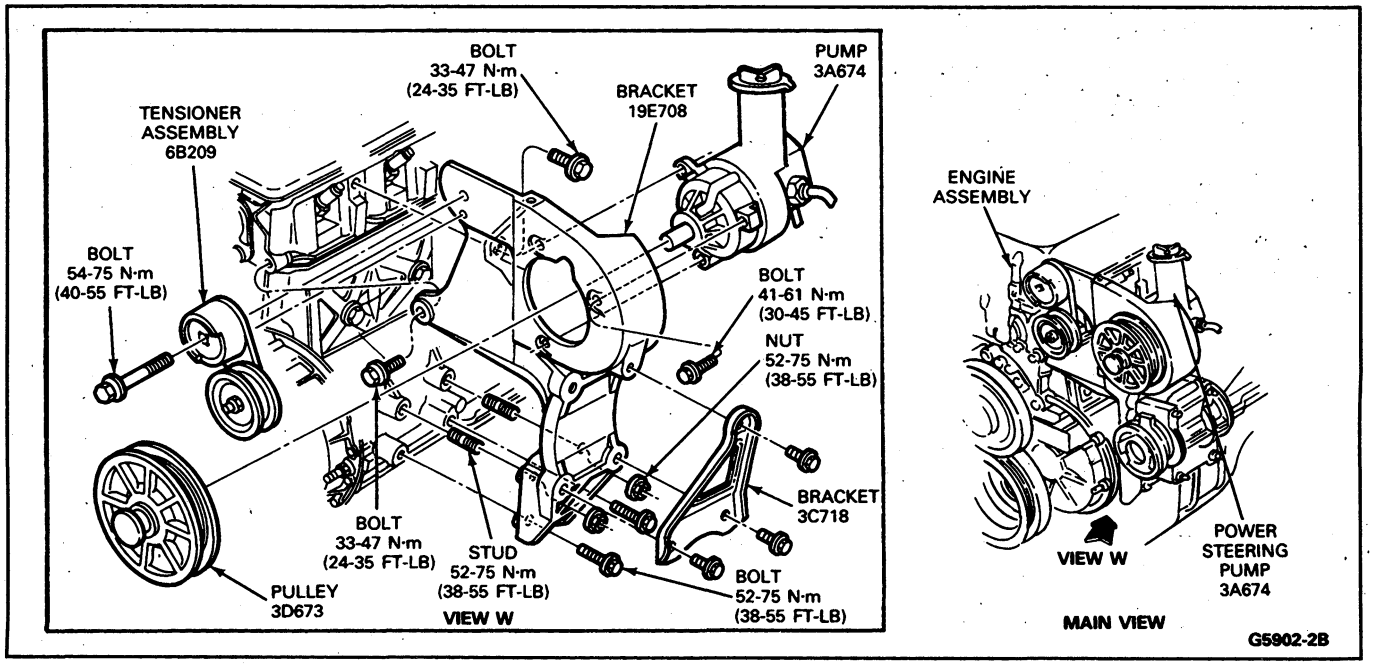


FIG. 4 Power Steering Pump Installation F-150—F-350 (4x2) (4x4), Bronco 4.9L (300 CID) EFI I-6 Gasoline Engine

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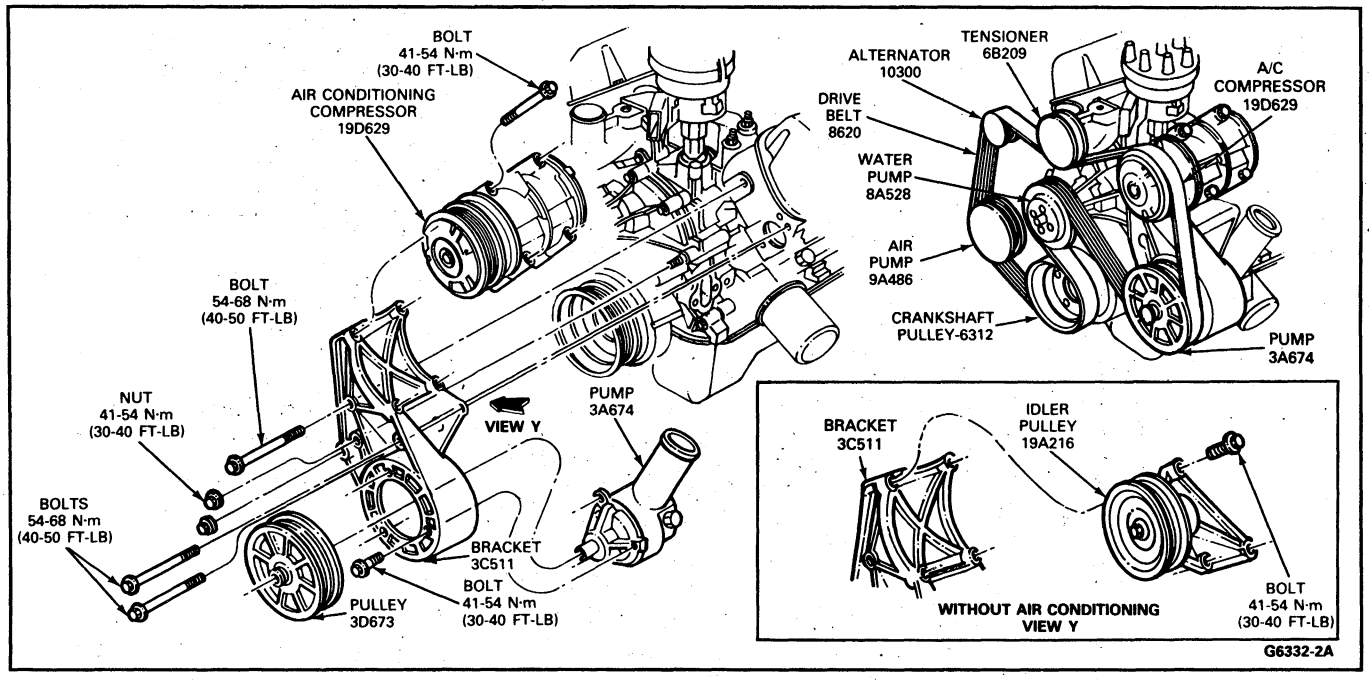


FIG. 5 Power Steering Pump Installation—F-150—F-350 (4x2) (4x4) and Bronco With 5.0L and 5.8L EFI Engine

Power Steering Pump Reservoir

Take the following precautions when servicing the power steering pump reservoir:

1. Use a clean work bench and tools.
2. Plug the inlet and outlet openings of the pump with plugs or masking tape.
3. Thoroughly clean the exterior of the pump with solvent.

Removal

1. Place the pump assembly in a bench vise with soft jaws (Fig. 9), and remove the outlet fitting, flow control valve and spring. Discard all seals.
2. Remove the fiberglass reservoir (Fig. 10).
3. Discard O-ring seal on pump housing plate (Fig. 11).

   NOTE: Do not hammer on the reservoir.

Installation

1. Install a new O-ring seal on the pump housing plate.
2. Apply petroleum jelly to the reservoir O-ring seal and the inside edge of the reservoir. Do not twist the O-ring seal (Fig. 12).
3. Place the reservoir over the pump and align the outlet fitting hole in the reservoir with the hole in the valve cover.
4. Be sure the reservoir is evenly seated on the pump housing plate.
5. Place a new O-ring seal on the outlet fitting. Install the spring, flow control valve and outlet fitting into the reservoir and valve cover. Tighten the fitting to 34-36 N·m (25-34 ft. lb.)

NOTE: If the valve is cocked, it may become stuck in the valve cover. Do not force the valve forward; forcing the valve may shear off metal and carry the metal chips into the valve bore.

DISASSEMBLY AND ASSEMBLY

Power Steering Pump

Refer to Figure 13.

The following precautions must be observed when servicing the power steering pump:

1. Use a clean work bench and tools.
2. Thoroughly clean the exterior of the pump with solvent. Drain as much fluid as possible.
3. If only the reservoir is to be removed, clean as detailed under Reservoir Removal.
4. If only the rotor shaft seal is to be removed, clean as detailed under Reservoir Removal.
5. Do not use cleaning solvent on the seals.

Disassembly

1. Remove the pump pulley as outlined under Pump Pulley Removal in this Section making sure the pump has been removed from the adjustment bracket.
2. Remove the outlet fitting, flow control valve, and spring from the pump. Remove the pump reservoir.
3. Place "C" clamp (Tool No. T74P-3044-A1) or equivalent in a bench vise.
4. Place the lower support plate (Tool No. T78P-3733-A2) or equivalent over the pump rotor shaft (Fig. 14).
5. Install the upper compressor plate (Tool No. T78P-3733-A1) or equivalent into the upper portion of the "C" clamp.
6. Holding the upper compressor tool, place the pump assembly into the "C" clamp with the rotor shaft facing down (Fig. 15).

   NOTE: Position the contour of the upper compressor tool to fit the contour of the pump valve cover.

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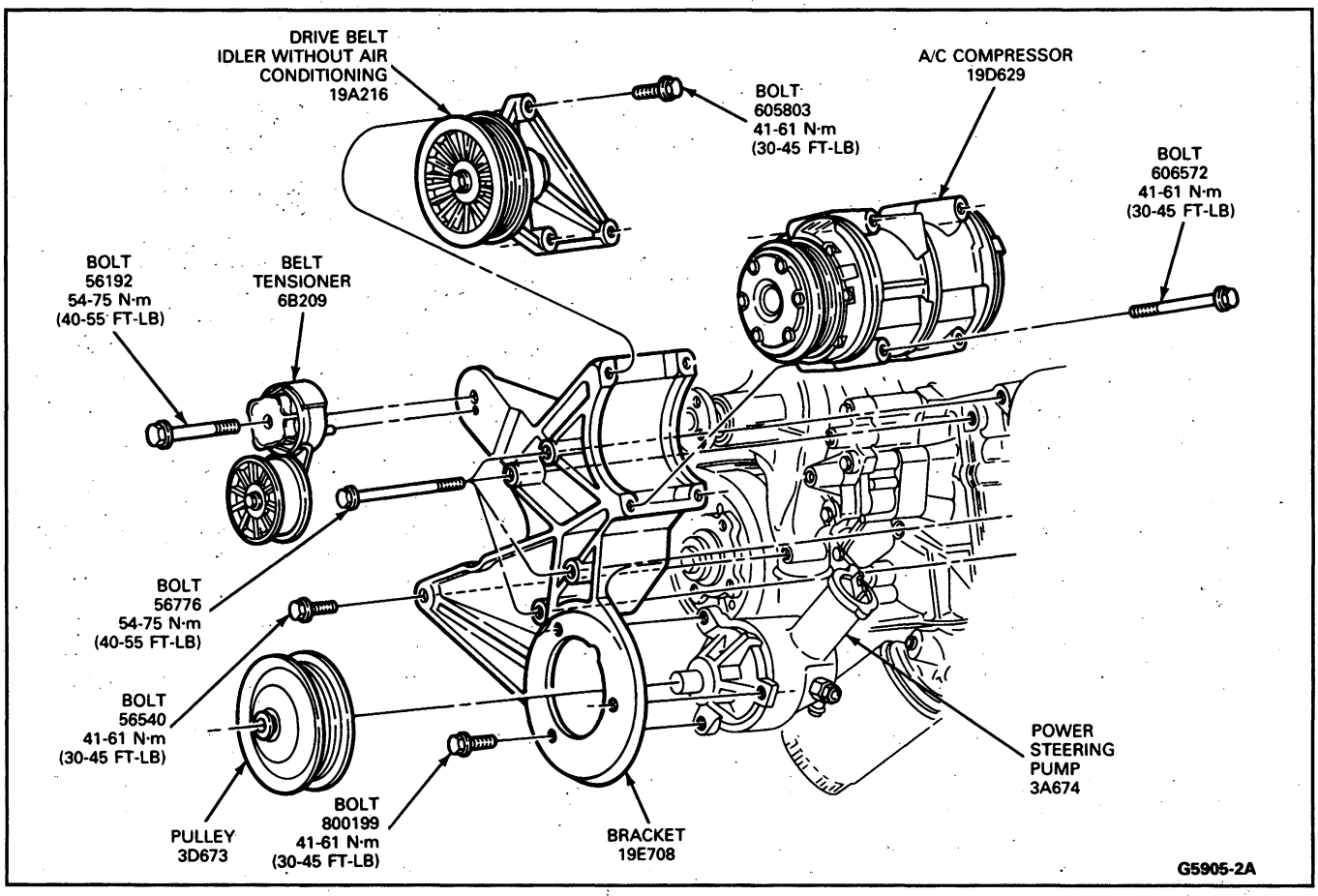


FIG. 6 Power Steering Pump Installation—7.5L EFI Engine

7. Tighten the "C" clamp until a slight bottoming of the valve cover is felt.
8. In the side of the pump housing plate is a small hole. Insert a small drift or suitable tool through this hole and push inward on the valve cover retaining ring. While applying pressure on the retaining ring, place a screwdriver under the edge of the retaining ring and remove the ring (Fig. 16).
9. Loosen the "C" clamp. Remove the upper compressor plate, and remove the pump assembly.
10. Remove the pump valve cover. Discard the O-ring seal.
11. Push on the rotor shaft, and remove the rotor shaft, upper plate, rotor and slippers, cam insert and (2) dowel pins (Fig. 17).
12. The lower plate and the disc spring will remain in the pump housing plate. To remove, place the pump housing plate on a flat surface. Raise slightly and slam the housing plate down flatly until the lower plate and the disc spring fall out. Discard the O-ring seals (Fig. 18).
13. Remove the rotor shaft seal and seal retainer simultaneously by prying out with a screwdriver (Fig. 19).

NOTE: This method is used only when the pump is disassembled.

Assembly

If the rotors, slippers, spring and cam insert were disassembled for cleaning and/or inspection, assemble as follows:

1. Place the rotor on the rotor shaft splines.
2. Install the retaining ring in the groove at the end of the rotor shaft.
3. Place the insert cam over the rotor. Be sure the recessed flat on the insert cam is toward the reservoir.
4. With the rotor extended upward approximately half way out of the cam, insert a spring into a rotor spring pocket.
5. Use one of the slippers to compress the spring and install the slipper with the narrow groove facing upward.
6. Hold the cam stationary, and turn the rotor either right or left one space at a time, and install another spring and slipper until all (10) rotor cavities have been filled. Be careful when turning the rotor, that the springs and slippers already installed do not fall out.
7. Install a new rotor shaft seal using seal driver Tool No. T78P-3733-A3, or equivalent. Using a plastic mallet, drive the seal into the bore until a bottoming is felt (Fig. 20). Install the seal retainer in the same manner.
8. Place the pump housing plate on a flat surface, with the pulley side facing down.

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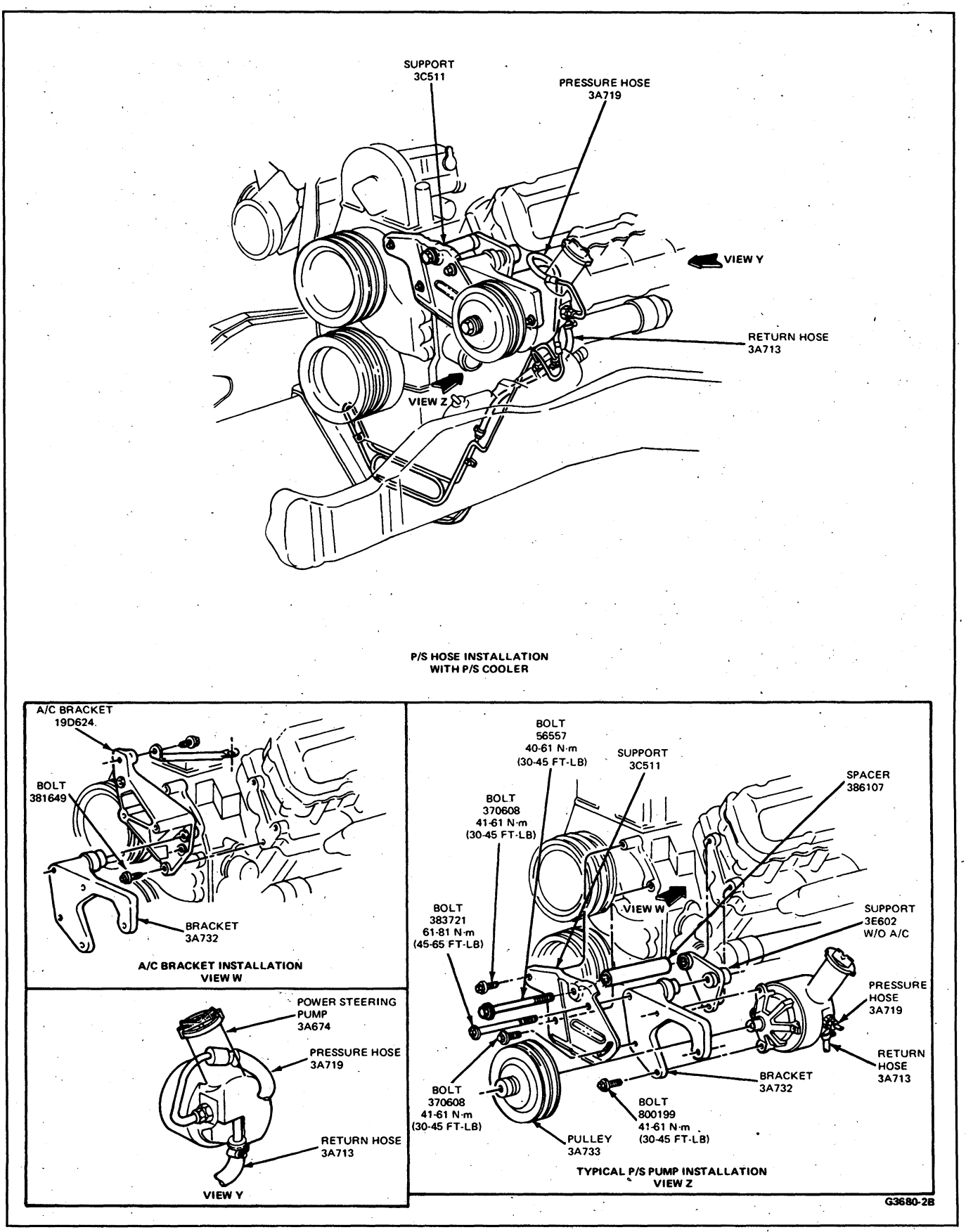


FIG. 7 Power Steering Pump Installation—7.3L Diesel Engine

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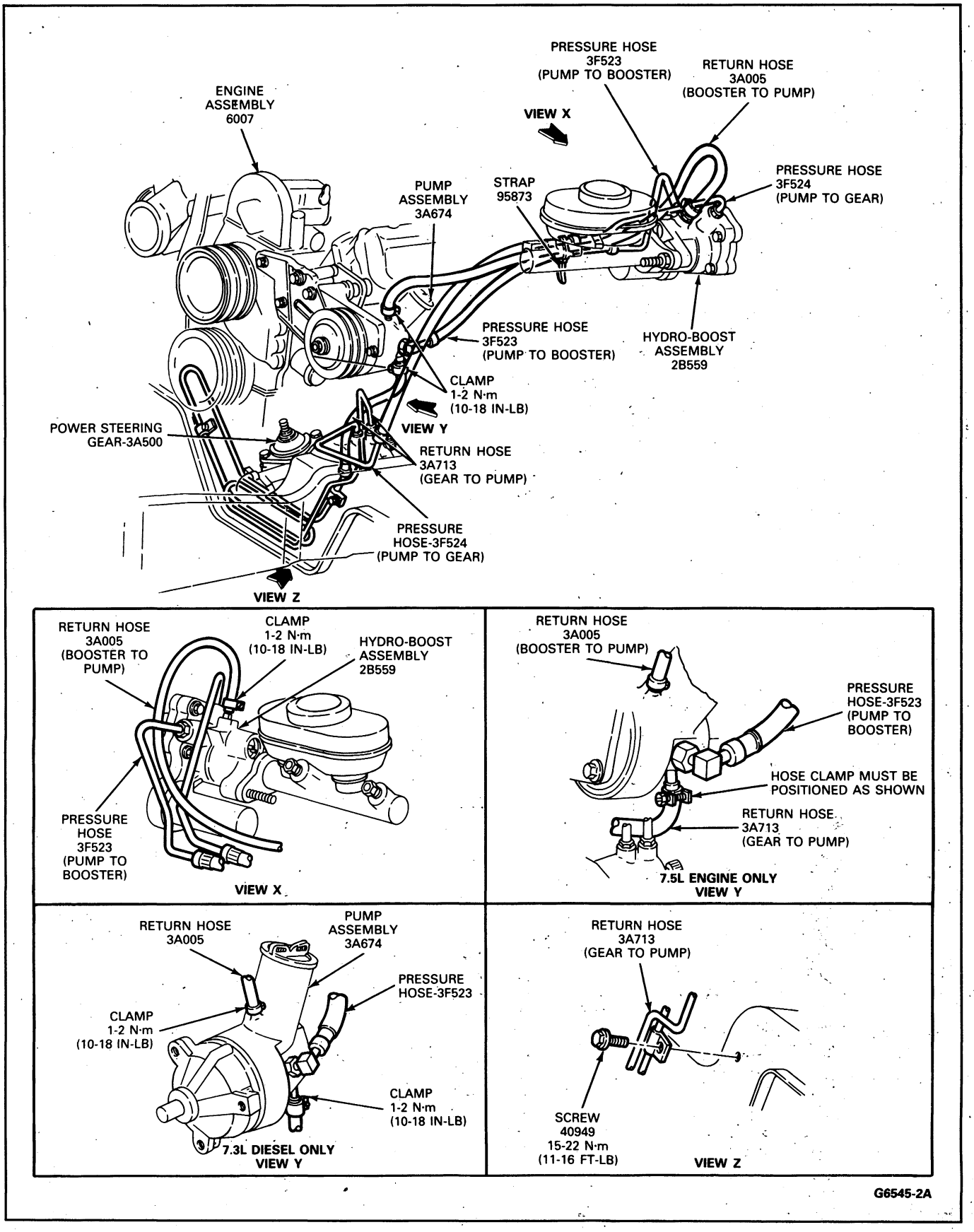


FIG. 8 Power Steering Pump Installation—F-Super Duty

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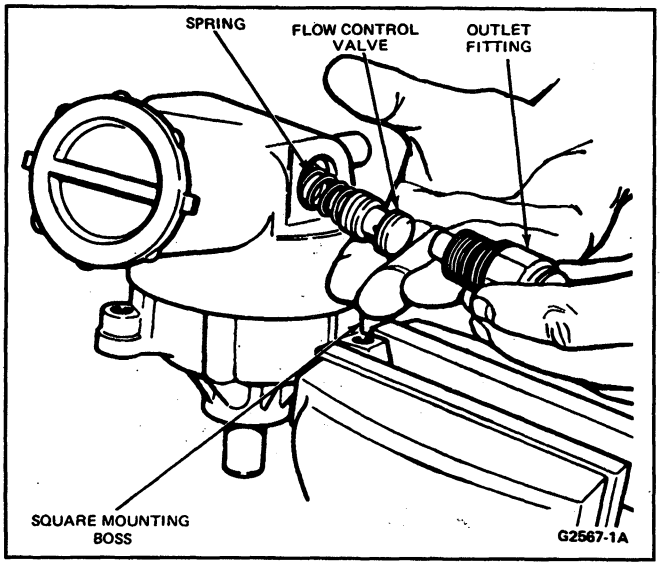


FIG. 9 Removing Outlet Fitting, Flow Control Valve and Spring

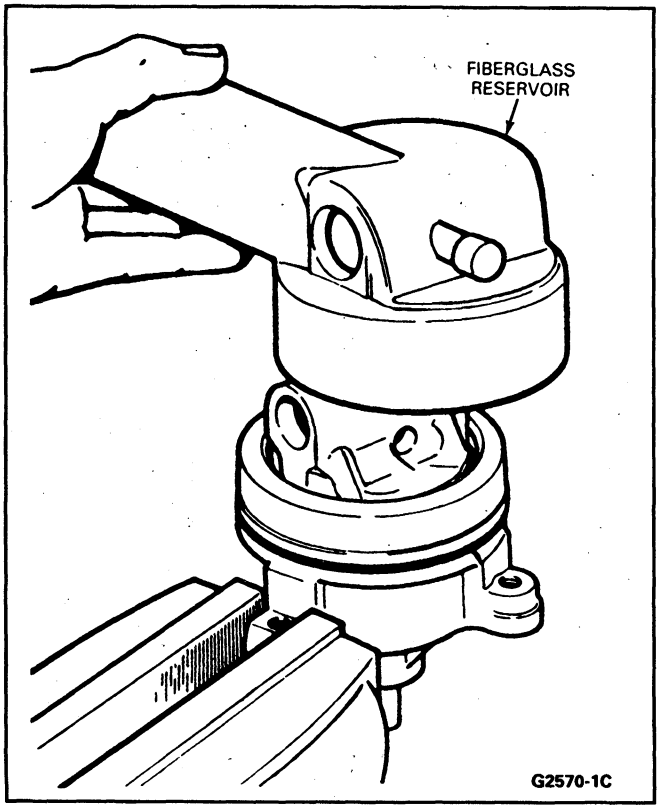


FIG. 10 Removing Reservoir

9. Insert the (2) dowel pins and the disc spring into the housing plate (Fig. 21).

   NOTE: The disc spring must be inserted with the dished surface upward.

10. Lubricate the inner and outer O-ring seals with the specified power steering fluid and install these seals on the lower pressure plate (Fig. 22).

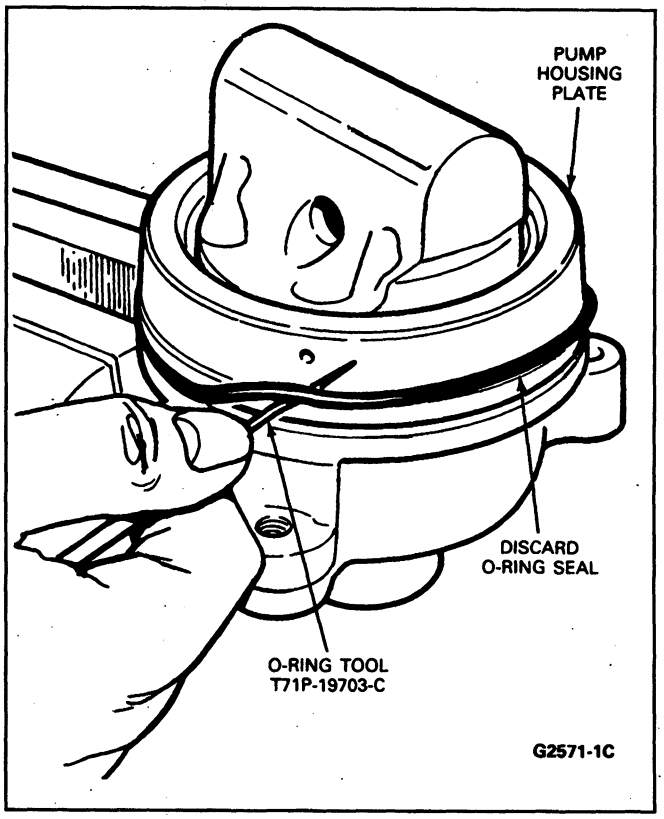


FIG. 11 Discarding O-ring Seal

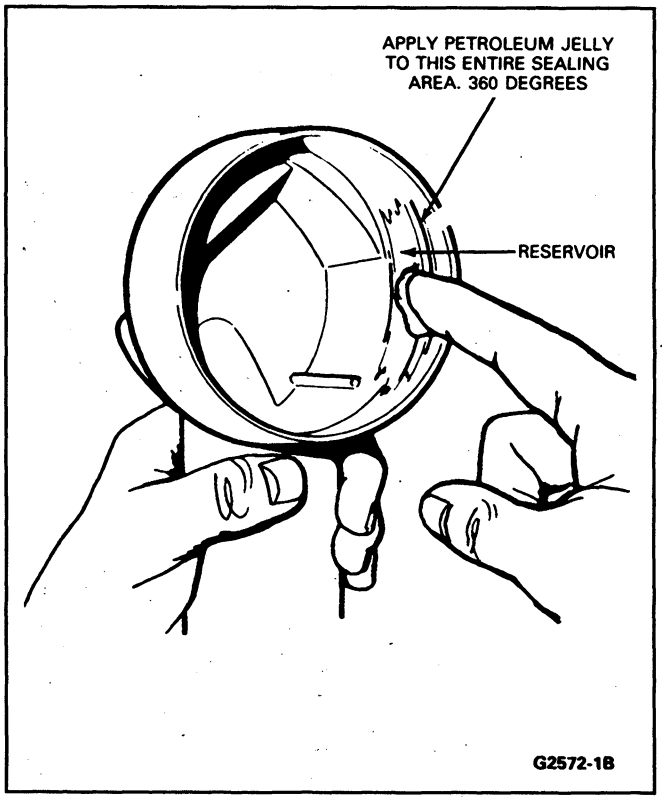


FIG. 12 Lubricating O-ring Seal

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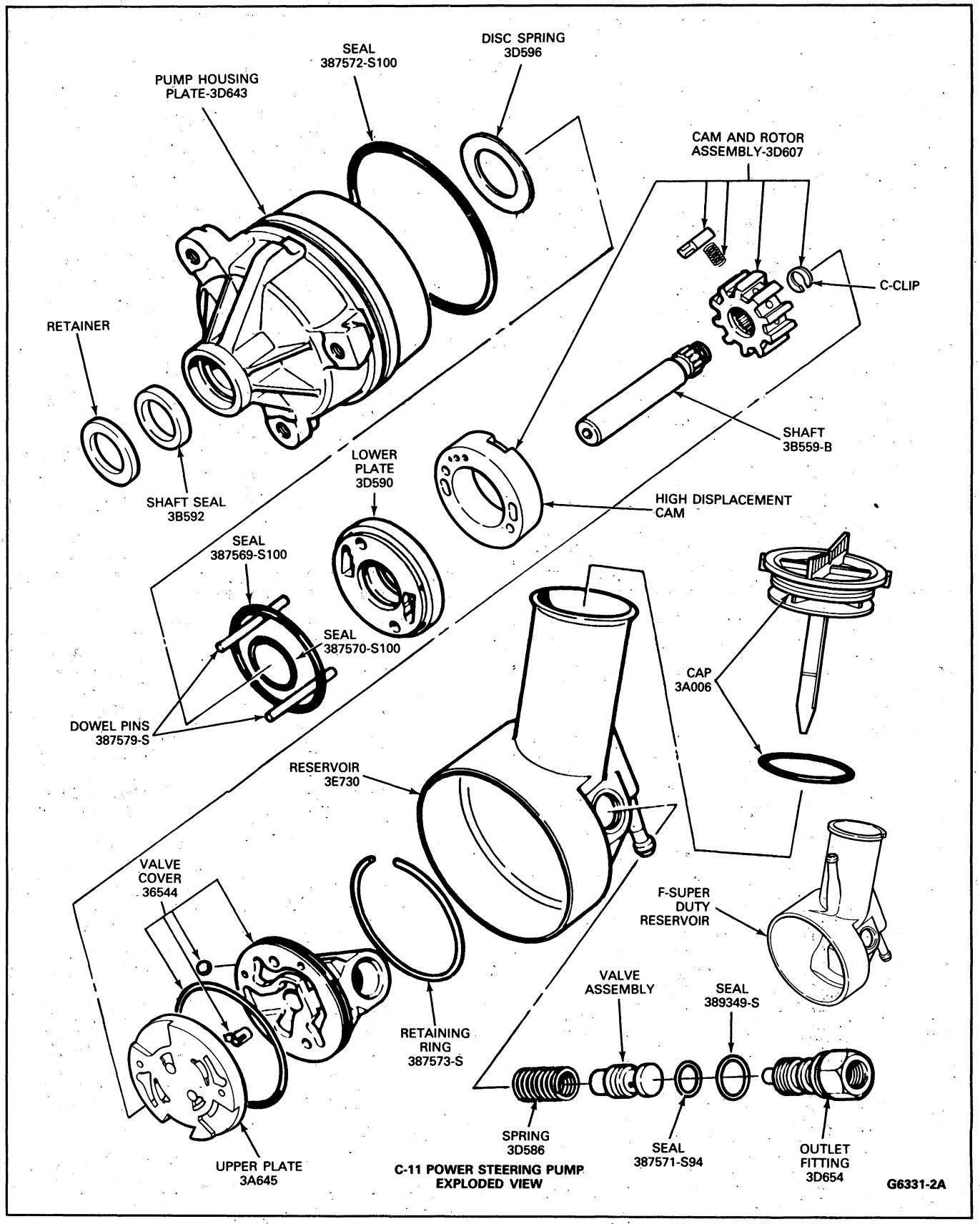


FIG. 13 C-II Power Steering Pump—Exploded View

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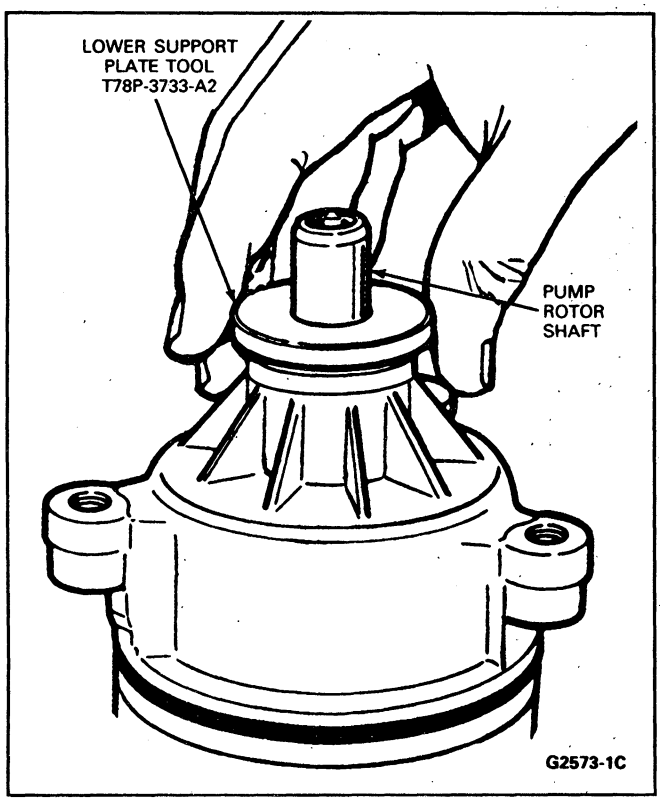


FIG. 14 Installing Lower Support Plate Tool

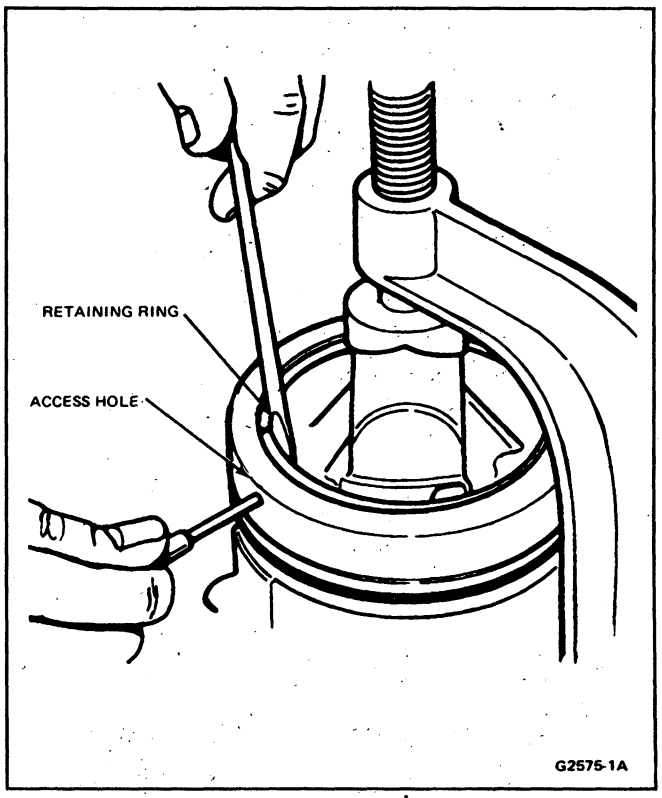


FIG. 16 Removing Retaining Ring

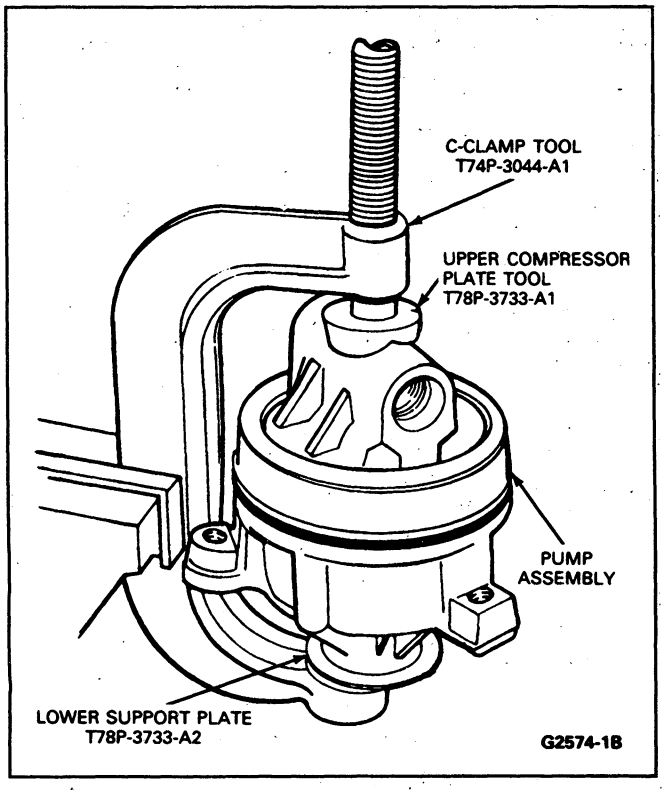


FIG. 15 Installing Compressor Plate Tool

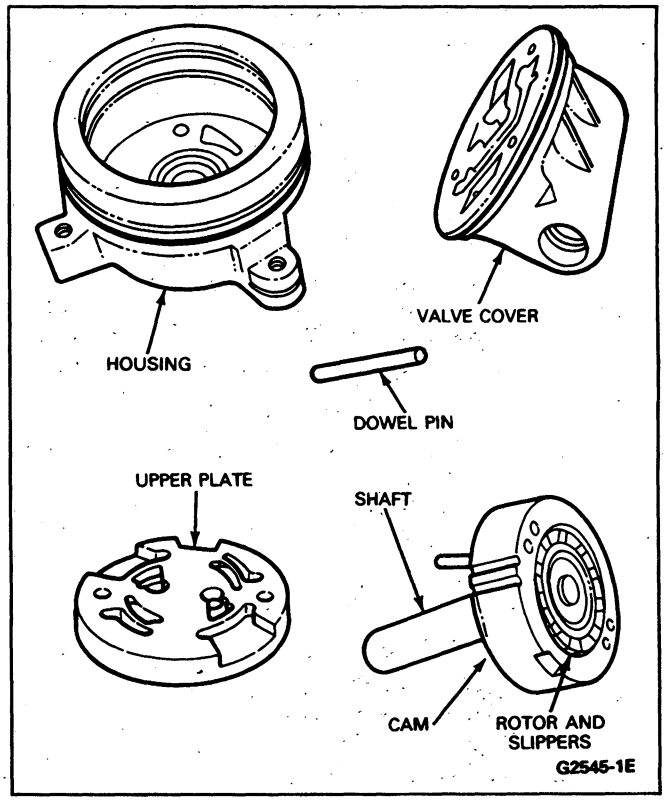


FIG. 17 Pump Housing Components

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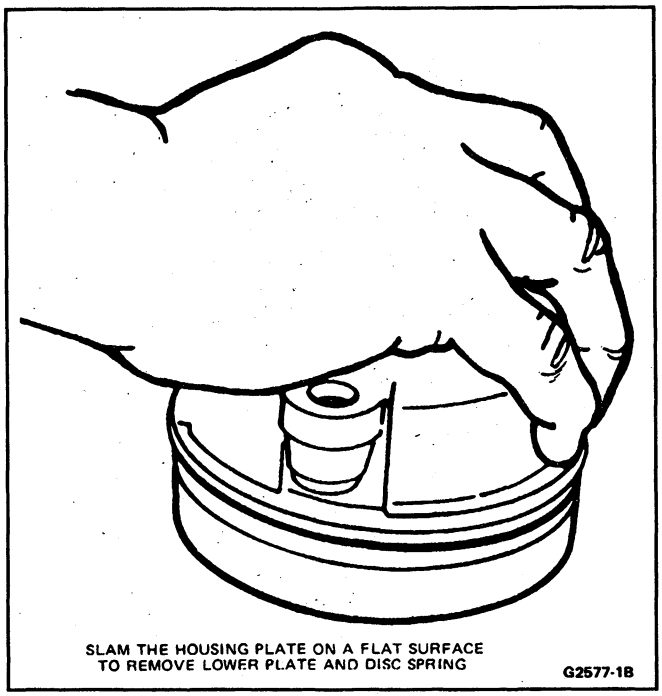


FIG. 18 Slamming the Housing Plate on a Surface to Remove Lower Plate and Disc Spring

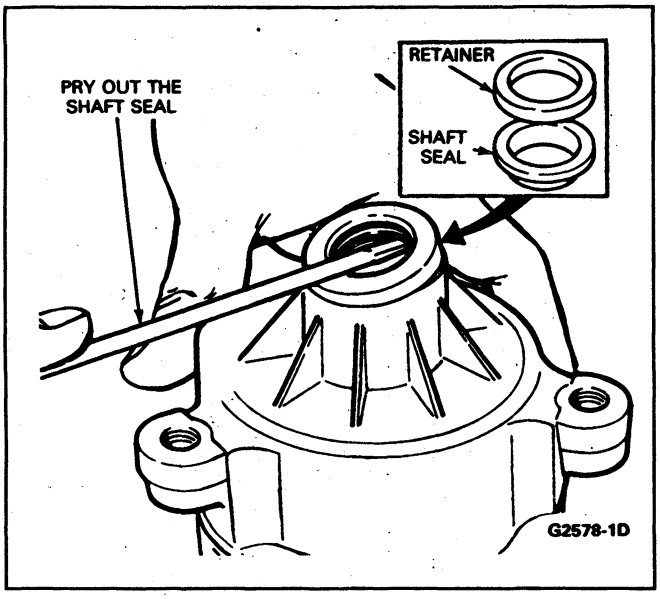


FIG. 19 Removing Rotor Shaft Seal

11. Insert the lower pressure plate with the O-ring seals toward the front of the pump into the pump housing plate (Fig. 23) and over the dowel pins. Place the entire assembly on the "C" clamp. Place driver Tool No. T78P-3733-A3 or equivalent into the rotor shaft hole (Fig. 24) and press on the lower plate lightly until it is felt to bottom into the pump plate housing. This operation will seat the outer O-ring seal (Fig. 25).
12. Install the cam, rotor and slippers, and rotor shaft assembly into the pump housing plate over the dowel pins (Fig. 26).

    NOTE: When installing this assembly into the pump housing plate, the stepped holes must be used for the dowel pins, and the recessed notch in the cam insert must face toward the reservoir and be approximately 180° opposite the square pump mounting boss.
13. Place the upper pressure plate over the dowel pins (Fig. 27). When installing the upper plate into the pump housing, observe the notch on the outside diameter of the plate. One side has a square recess cast into the plate. This square recess must

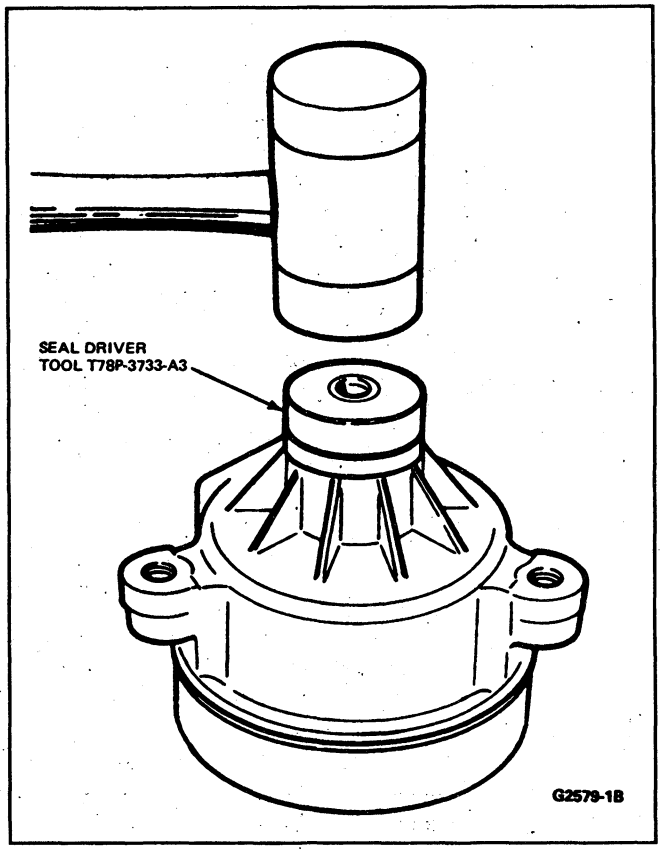


FIG. 20 Installing Rotor Shaft Seal

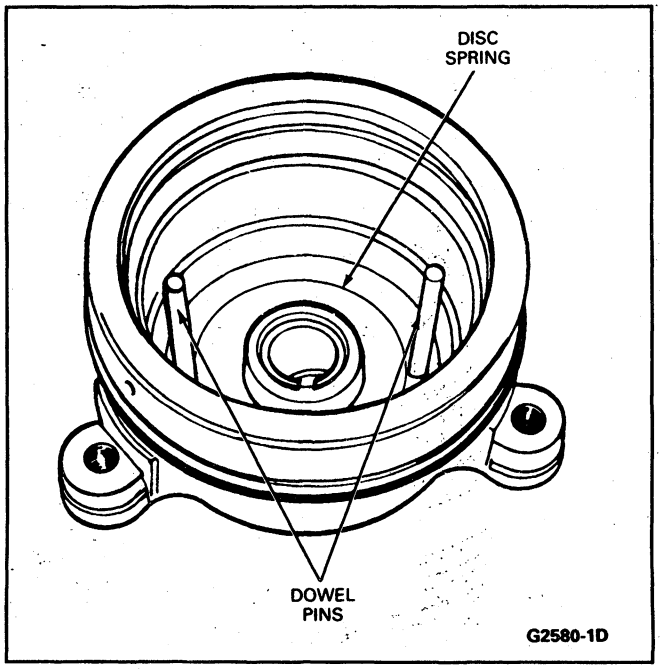


FIG. 21 Installing Disc Spring and Dowel Pins

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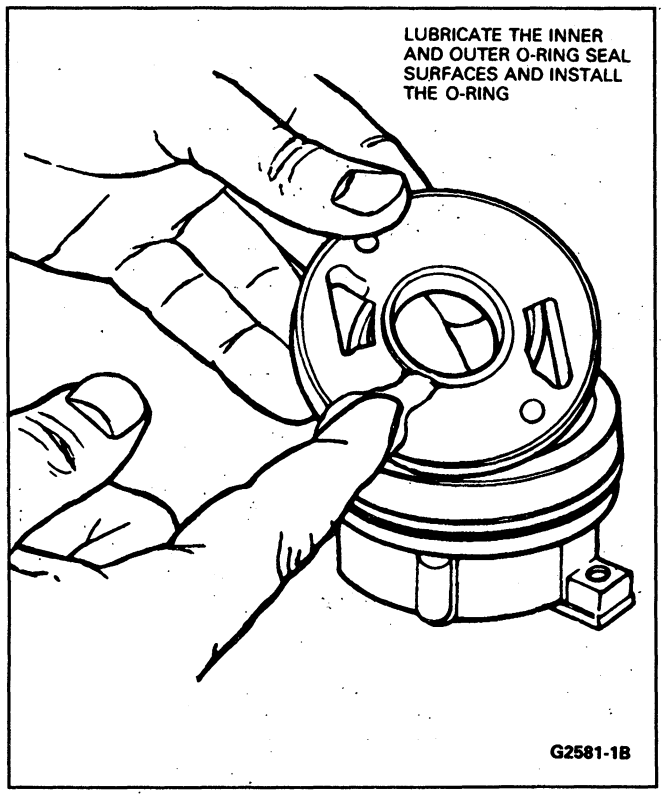


FIG. 22 Lubrication and Installation of O-rings

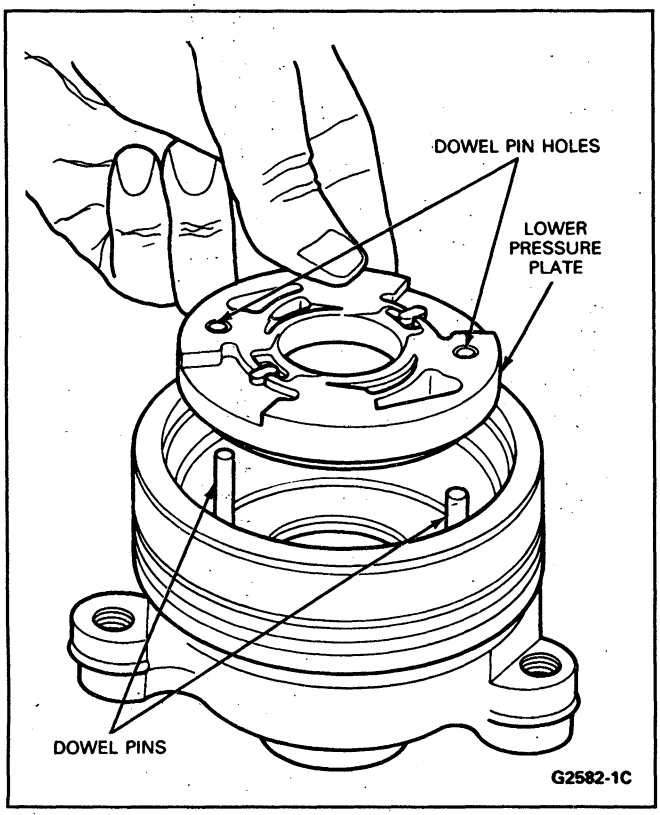


FIG. 23 Installing the Lower Plate with the Seals Facing Toward the Pump Housing

be facing toward the reservoir and positioned approximately 180° opposite the pump square mounting boss.

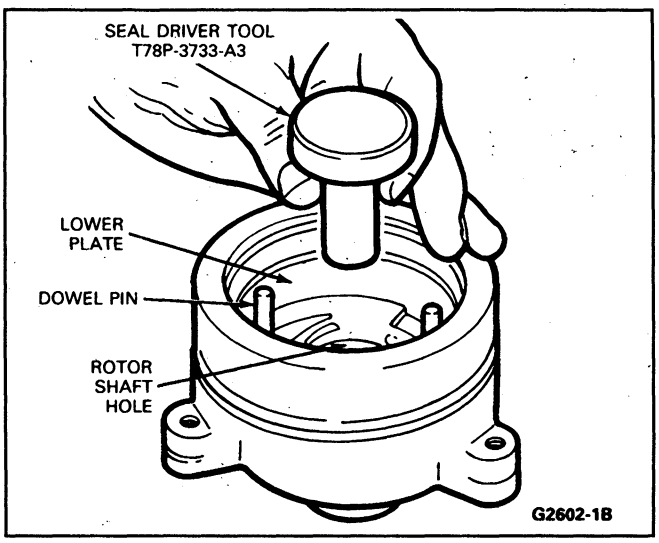


FIG. 24 Place Driver Tool Rotor Shaft Hole

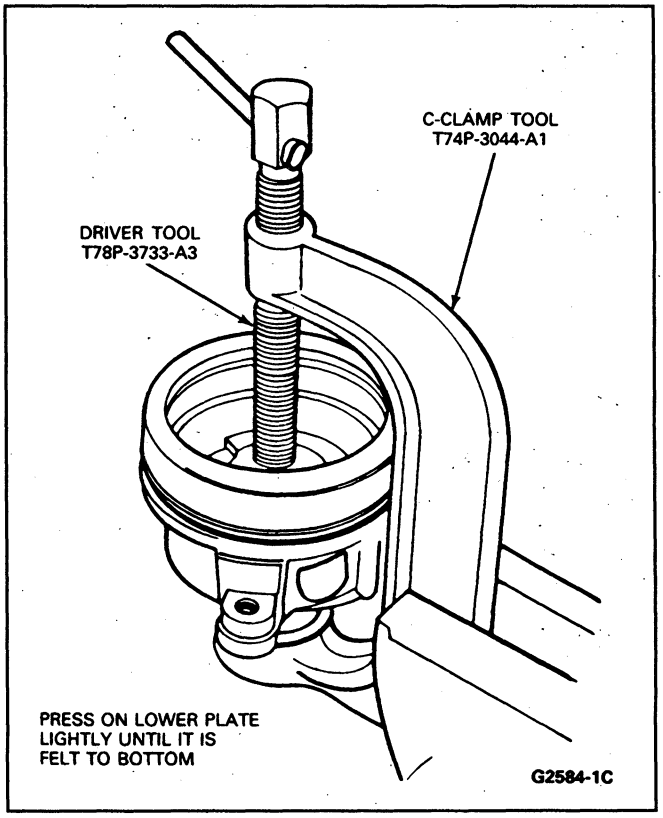


FIG. 25 Seating Outer O-ring Seal

14. Place a new O-ring seal on the valve cover. Lubricate this seal with the specified power steering fluid (Fig. 28).

    NOTE: Be sure the plastic baffle is securely in place in the valve cover. If the baffle is loose, apply a coating of petroleum jelly on the baffle and install it into location on the valve cover.

15. Insert this valve cover over the dowel pins. Be sure the outlet fitting hole in the valve cover is directly in line with the square mounting boss of the pump housing plate (Fig. 29).

16. Place the entire assembly in the "C" clamp tool and compress the valve cover into the pump

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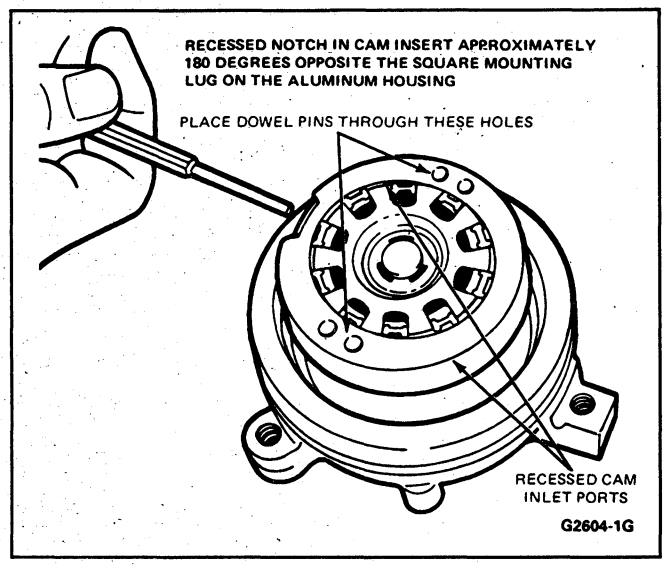


FIG. 26 Installing Cam, Rotor and Slippers

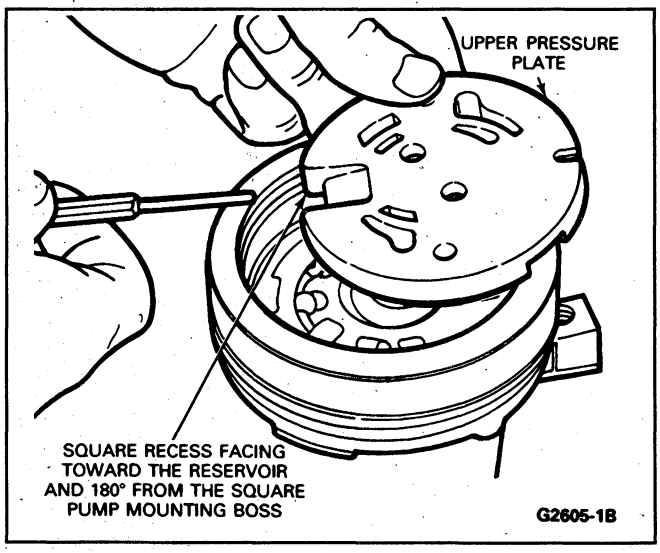


FIG. 27 Installing Upper Pressure Plate

housing plate, until the retaining ring groove is exposed in the pump housing plate.

17. Install the valve cover retaining ring with the ends near the access hole in the pump housing plate (Fig. 30).
18. Remove the pump assembly from the "C" clamp tool.
19. Place a new O-ring seal on the pump housing plate. Lubricate this O-ring seal with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent.
20. Install the power steering reservoir.
21. Install the flow control spring, and flow control valve into the valve cover.

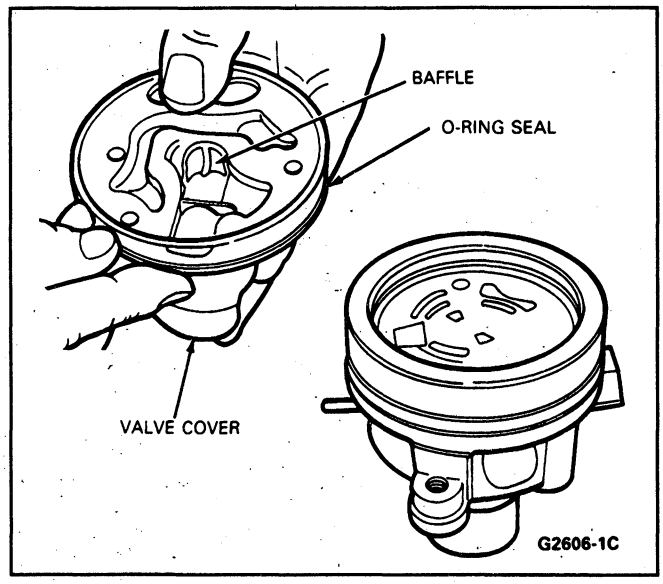


FIG. 28 Installing Valve Cover O-ring Seal

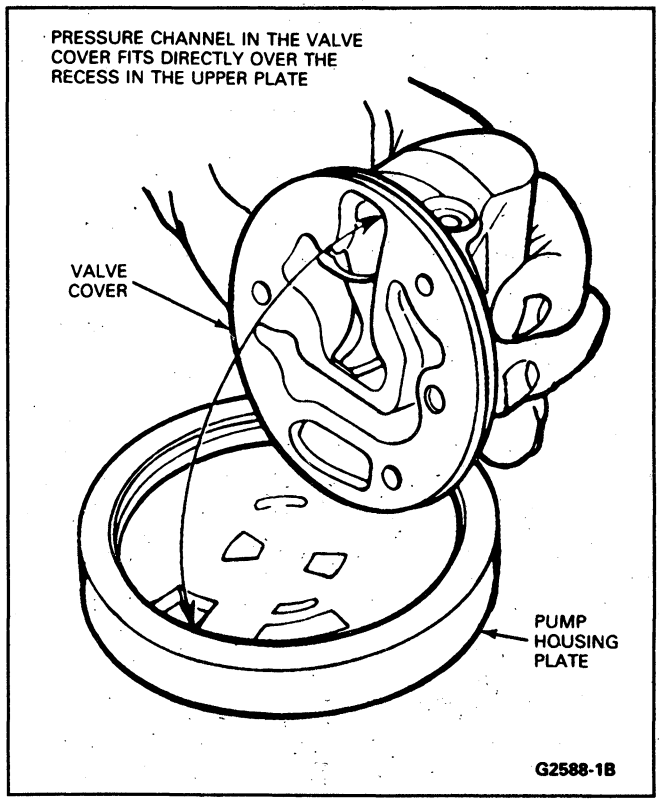


FIG. 29 Installing Valve Cover

22. Place new O-ring seals on the outlet fitting. Lubricate these seals with Premium Power Steering Fluid, E6AZ-19582-AA (ESW-M2C33-F) or equivalent.
23. Install the outlet fitting into the valve cover and tighten to 34-46 N·m (25-34 ft-lbs) (Fig. 31).

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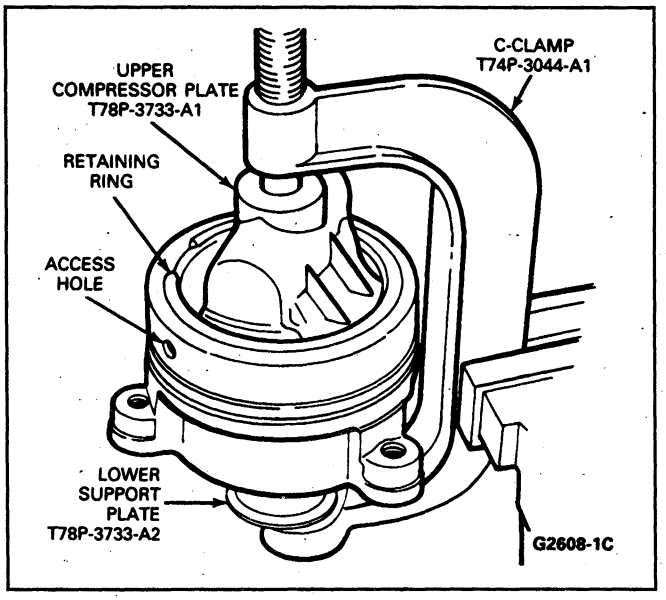


FIG. 30 Installing Valve Cover Retaining Ring

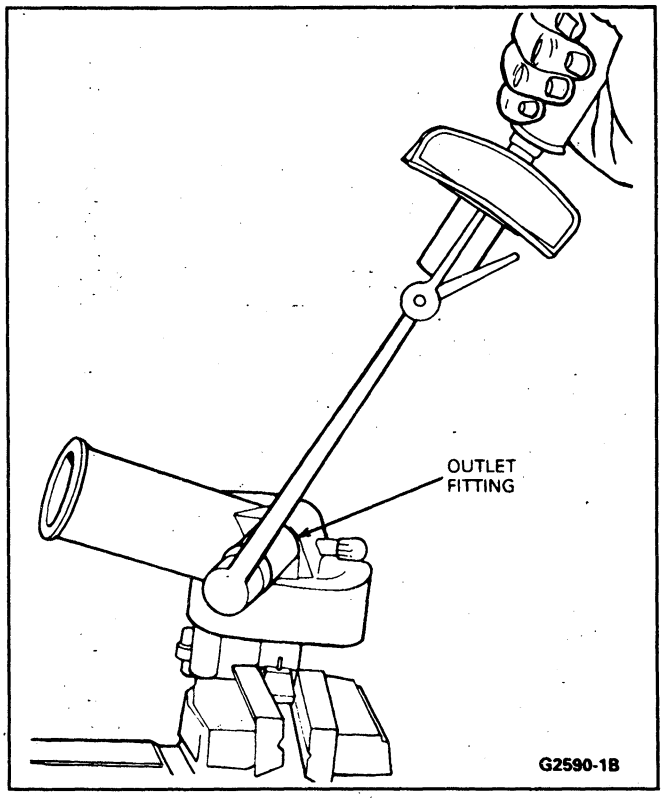


FIG. 31 Installing Outlet Fitting

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T57L-500-B	Bench Mounted Holding Fixture	Universal
TOOL-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T74P-3044-A1	C-Frame and Clamp Assembly	CII Power Steering Pump — Use with Power Steering Pump Tools
T78P-3733-A	Power Steering Pump Tools	CII Power Steering Pump — Use with C-Frame and Clamp Assembly
D79L-7000-A	Retaining Ring Pliers	Internal and External Retaining Rings
T63L-8620-A	Belt Tension Gauge	Universal
T69L-10300-B	Power Steering Pump Pulley Remover	CII — Power Steering Pump
T71P-19703-C	O-Ring Tool	Universal
T68L-33610-AB	Thermometer	Use with Power Steering Pump Analyzer
D79L-33610-A	Power Steering Pump Analyzer	All Vehicles
T65P-3A733-C	Steering Pump Pulley Replacer	CII — Power Steering Pump — 35.05mm (1-3/8 Inches) Wide Pulley

CG3143-2G

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CII POWER STEERING PUMP TORQUE SPECIFICATIONS

Description	4.9L (300 CID) I-6		5.0L (302 CID) V-8		5.8L (351 CID) V-8 6.6L (400 CID) V-8	
	N·m	(ft-lbs)	N·m	(ft-lbs)	N·m	(ft-lbs)
Pivot Bolt	41-61	30-45	61-88	45-65	—	—
Pump to Adjustment Bracket	41-61	30-45	41-61	30-45	41-61	30-45
Adjustment Bracket to Support Bracket	41-61	30-45	41-61	30-45	41-61	30-45
Support Bracket to Engine	—	—	—	—	61-88	45-65
Support Bracket to Water Pump Housing	16-23	12-17	41-61	30-45	41-61	30-45
Pressure Hose to Rear Fitting	19-39	14-29	19-39	14-29	19-39	14-29
Pump Outlet Fitting to Pump Valve Cover	34-46	25-34	34-46	25-34	34-46	25-34
Return Hose to Gear Fitting	23-43	17-32	23-43	17-32	23-43	17-32
Return Line to Frame	15-21	11-16	15-21	11-16	15-21	11-16
Return Hose to Pump (Hose Clamp)	1.3-2.7	12-24 in-lbs	1.3-2.7	12-24 in-lbs	1.3-2.7	12-24 in-lbs

Description		7.5L (460 CID) Gas Engine		6.9L Diesel Engine	
		N·m	(ft-lbs)	N·m	(ft-lbs)
Pivot Bolt		41-61	30-45	41-61	30-45
Pump to Adjustment Bracket		41-61	30-45	41-61	30-45
Adjustment Bracket to Support Bracket	Long Bolt	61-81	45-65	61-81	45-65
	Short Bolt	41-61	30-45	41-61	30-45
Pressure Hose to Rear Fitting		19-39	14-29	19-39	14-29
Pump Outlet Fitting to Pump Valve Cover		34-46	25-34	34-46	25-34
Return Hose to Gear Fitting		23-43	17-32	23-43	17-32
Return Line to Frame		15-21	11-16	15-21	11-16
Return Hose to Pump (Hose Clamp)		1.3-2.7	12-24 in-lbs	1.3-2.7	12-24 in-lbs

CG2646-2B

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SECTION 13-57 Power Steering Pump—ZF

SUBJECT	PAGE
DESCRIPTION AND OPERATION	13-57-1
DIAGNOSIS AND TESTING	13-57-1
DISASSEMBLY AND ASSEMBLY	
Power Steering Pump	13-57-5
REMOVAL AND INSTALLATION	
Filter Element	13-57-5
REMOVAL AND INSTALLATION (Cont'd.)	
Power Steering Pump	13-57-3
SPECIAL SERVICE TOOLS	13-57-8
VEHICLE APPLICATION	13-57-1

VEHICLE APPLICATION

All F-Super Duty Commerical Stripped Chassis and Motor Home Chassis Vehicles.

DESCRIPTION AND OPERATION

The ZF power steering pump has been specially designed to supply pressurized oil to power steering units.

The ZF power steering pump is directly driven by the engine. As the driven shaft rotates the rotor, the slipper vanes inside the pump also move. The centrifugal force and pressurized oil forces the slipper vanes against the track of the cam ring. The oil passes from the two pressure chambers to the area between the rear cover and faceplate, thus pressing this plate against the cam ring at operating pressure. The oil then passes through a flow-limiting valve to the pressure line.

DIAGNOSIS AND TESTING

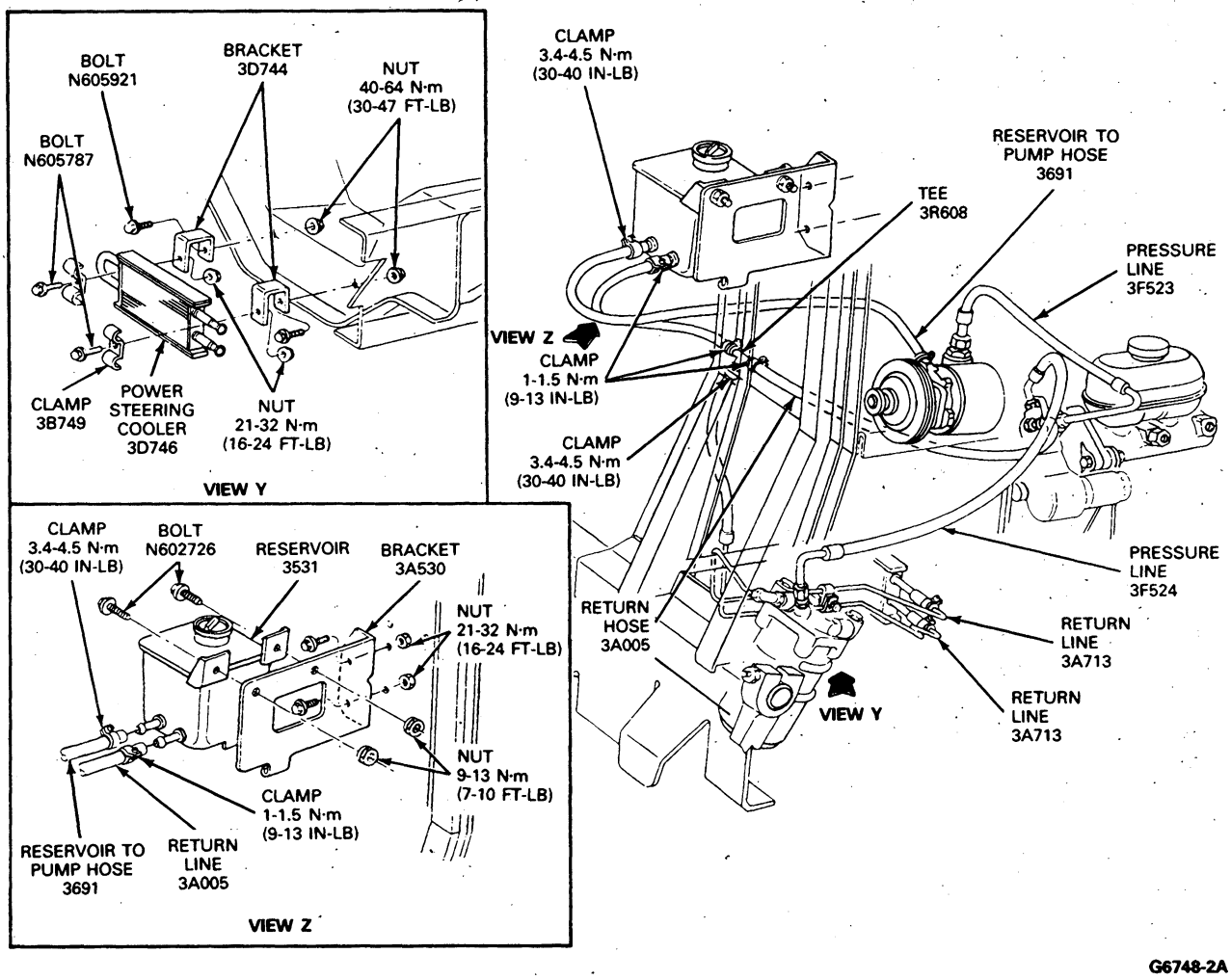
Refer to Section 13-01, General Stering Service for diagnostic and testing procedures.

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REMOVAL AND INSTALLATION

Always tag pump hoses before removal so they can be easily connected to their proper ports during installation.

Power Steering System—Motor Home Chassis with 7.5 EFI Engine



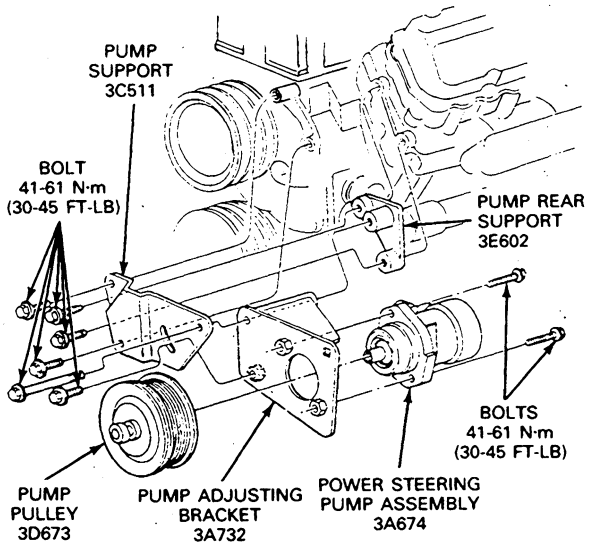
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REMOVAL AND INSTALLATION (Continued)

Power Steering Pump

Removal

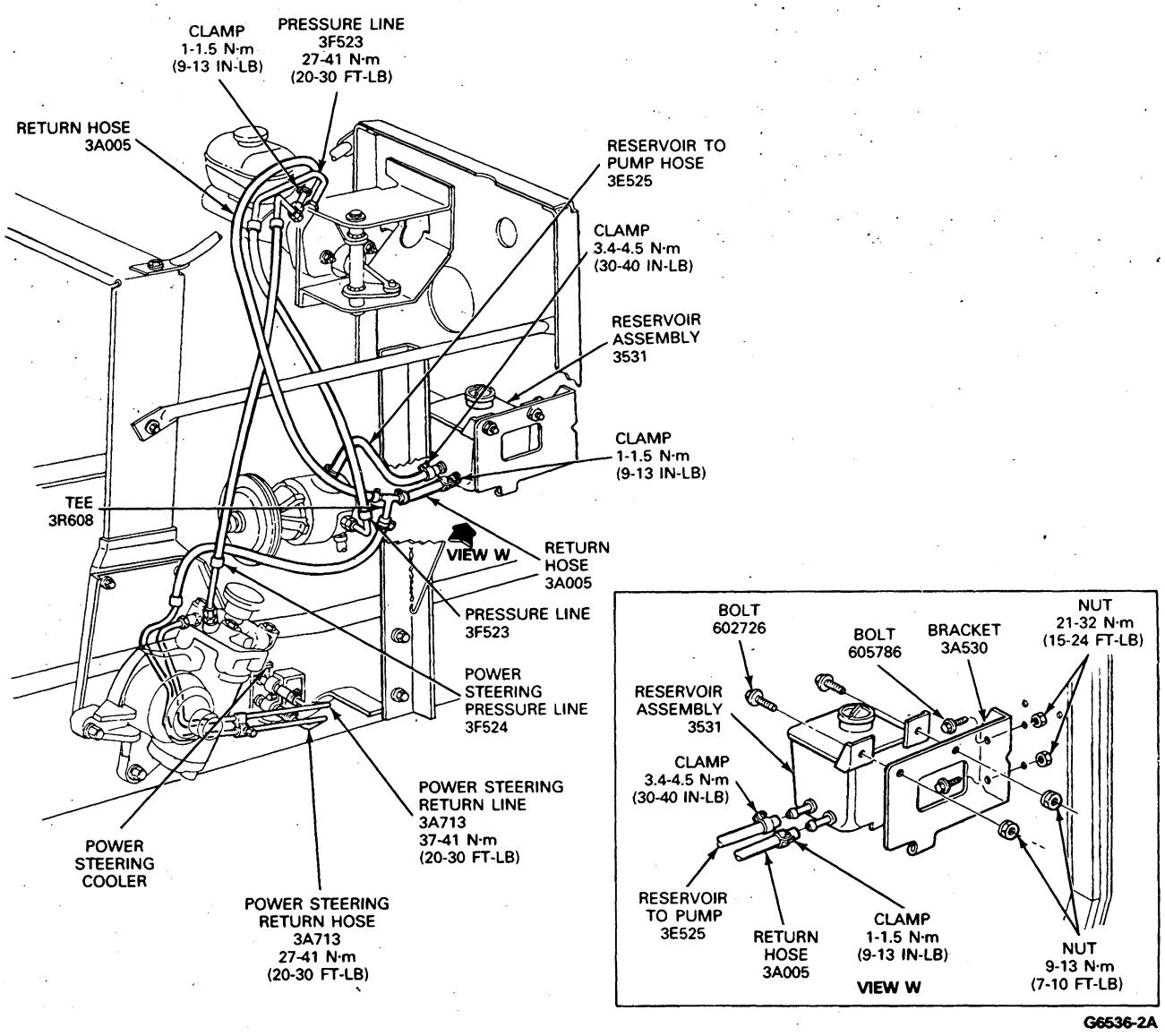
1. Using a suction gun, remove as much fluid as possible from the reservoir through the filler opening or remove the return hose to drain the reservoir.
2. Disconnect both hoses from the pump. Fasten both hoses in a raise position or plug disconnected ends to prevent the fluid from draining out.
3. Loosen the power steering pump pivot bolt and adjusting bolt. Remove the drive belt.
4. Remove the two power steering pump mounting bolts and remove the complete pump assembly.



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REMOVAL AND INSTALLATION (Continued)

Power Steering System—Commercial Stripped Chassis with 7.3L Diesel



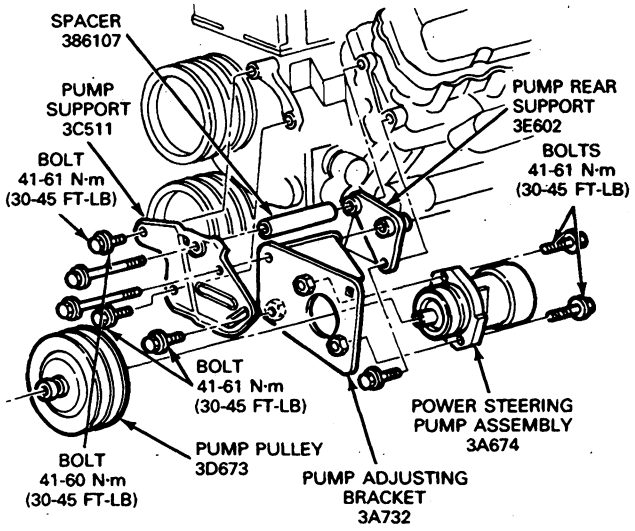
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REMOVAL AND INSTALLATION (Continued)

Installation

1. Install the pump assembly and tighten the pump mounting bolts to 41-61 N.m (30-45 ft-lb.)
2. Adjust the pump belt tension to 490-662 N (110-140 lb) per strand on new belts, or belts, using belt tension gauge tool T63L-8620-A or equivalent. Tighten the adjusting and pivot bolts.
3. Connect all hoses to the pump, being sure to connect all lines to the correct ports.
4. Fill the reservoir to specifications as described under Fluid Level Check in Section 13-01, General Steering Service.

POWER STEERING PUMP INSTALLATION
COMMERCIAL STRIPPED CHASSIS



7.3L DIESEL ENGINE G6535-1B

Filter Element

NOTE: After a major power steering system failure due to a pump or gear damage requiring replacement or major overhaul, the system must be purged and a new filter installed.

Removal

1. Using a suction gun, remove fluid from the reservoir through the filler opening or remove return hose to drain reservoir.
2. Remove cover from reservoir by holding down spring loaded cover and removing wing nut, washer and gasket.
3. Take out spring, filter cap and filter.

Installation

1. Install replacement filter, filter cap and spring.
2. Install gasket, cover, washer and wing nut.
3. Fill reservoir to the cold mark with Motorcraft MERCON ® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or - DDX (ESP-M2C166-H) or equivalent.

DISASSEMBLY AND ASSEMBLY

Power Steering Pump

Disassembly

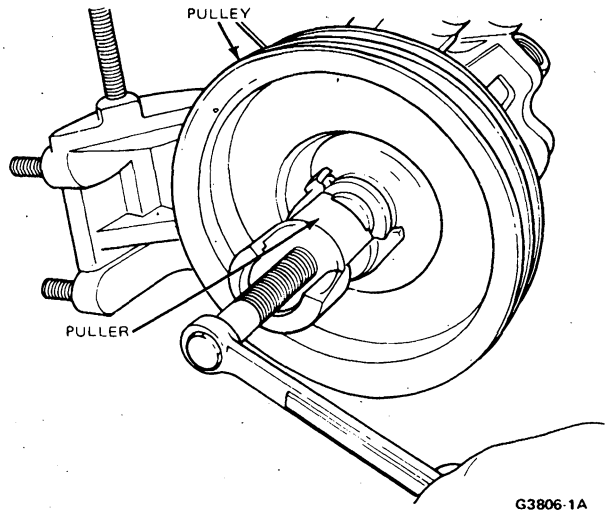
Clean all dirt and oil from the external surface of the pump after removal. Handle all pump parts carefully to avoid nicks, burrs, scratches and dirt.

CAUTION: To assure correct reassembly, record or mark all information as specified in the procedure.

1. For pumps with remote reservoirs, tip the pump to drain all oil from the intake tube. Rotate shaft to remove oil from internal cavities.
2. Using the pump mounting bracket, clamp the pump assembly into a bench vise in such a position as to facilitate pump disassembly.

CAUTION: Do not clamp on the pump or pulley.

3. Remove pulley with appropriate puller such as T69L-10300-B or equivalent.

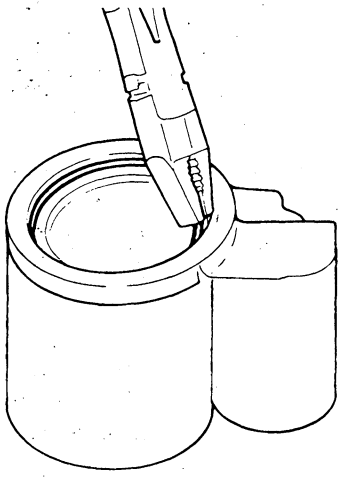


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DISASSEMBLY AND ASSEMBLY (Continued)

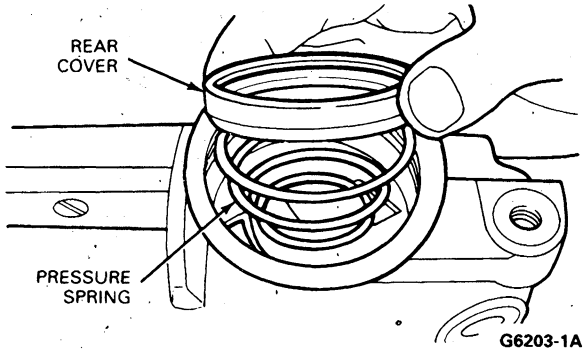
4. Compress rear pump cover.
5. Removing hook spring ring from radial groove in housing using pliers.



G6202-1A

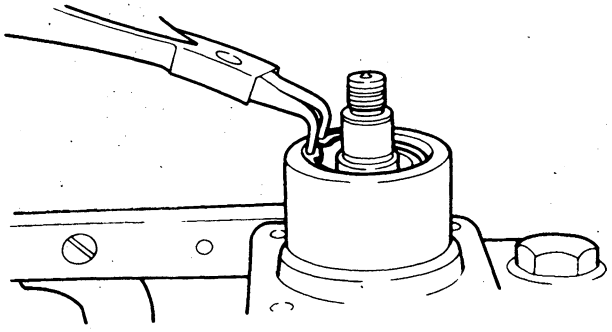
6. Remove cover and pressure spring. Remove internal O-ring and backup ring from rear cover.

NOTE: O-ring is inboard of backup ring.



G6203-1A

7. Remove the circlip from the groove.

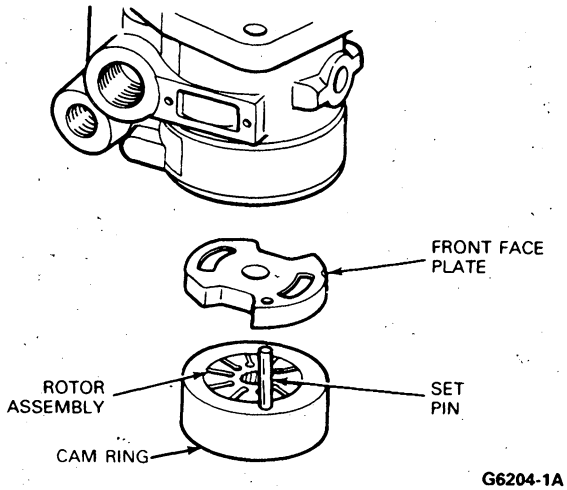


G5084-1A

8. Turn the housing over and remove the rear face plate. Remove O-ring and backup ring for the rear face plate from the housing. Remove the rotor assembly (rotor, cam ring, vanes and set pin) and front face plate from the housing.

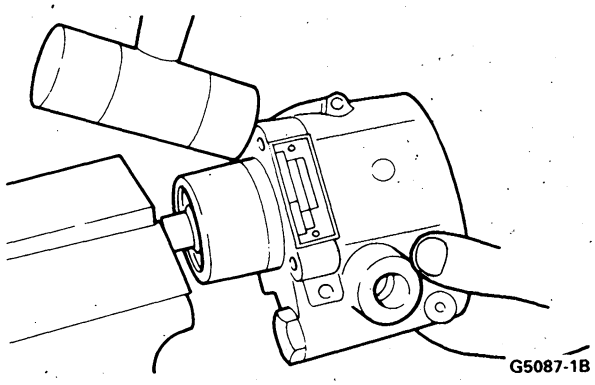
NOTE: This O-ring is outboard of the backup ring.

NOTE: Check direction of rotation (arrow on cam ring) and location of the set pin:



G6204-1A

9. Clamp driveshaft in vice (use soft jaws) and with a soft mallet, tap on the housing to remove the driveshaft from the housing.

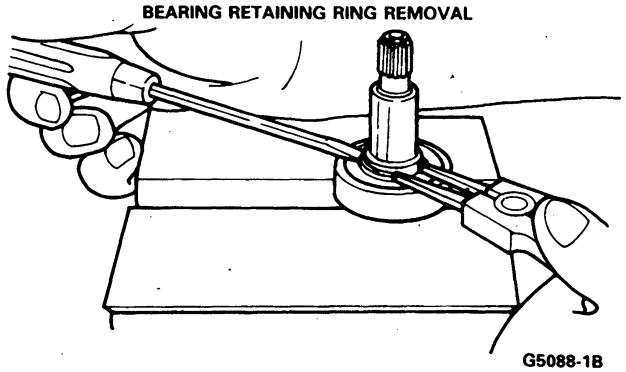


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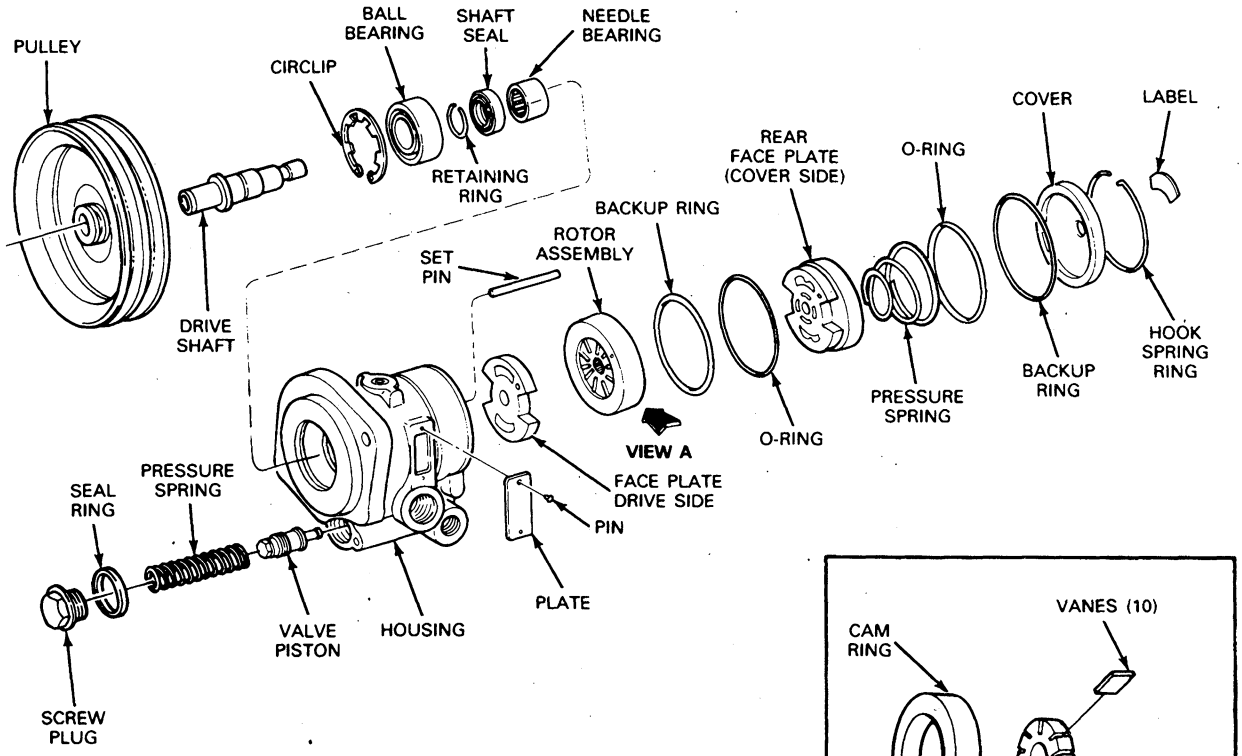
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DISASSEMBLY AND ASSEMBLY (Continued)

10. If the ball bearing is to be replaced, remove the retaining ring and press the bearing from the driveshaft.
11. If the shaft seal requires services, pry the seal from the housing. Discard the seal. If the needle bearing requires service, press the needle bearing from the housing.



G5088-1B



ROTOR ASSEMBLY – EXPLODED VIEW
VIEW A

G6537-2A

Assembly

1. If removed, press in a new needle bearing.
2. If removed, install a new shaft seal in the housing.
3. If removed, press a new bearing onto the driveshaft. Install the retaining ring in the driveshaft groove.
4. Install the driveshaft and bearing assembly into the housing.
5. Install the bearing circlip in the groove.
6. Install O-ring and backup ring on the rear faceplate in accordance with exploded view.
7. Install the set pin, front faceplate and rotor assembly into the housing.

NOTE: The cam ring of the rotor assembly must be installed with the arrow pointed in the direction of rotation.

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DISASSEMBLY AND ASSEMBLY (Continued)

8. Install the O-ring and backup ring in the rear cover housing in accordance with exploded view. Place the rear pressure spring in the rear face plate. Position the rear cover in the housing.
9. Press down on the rear cover plate and install the hook spring ring in the groove in the housing.
10. Press on the pulley with Tool T65P-3A733-C, or equivalent.

SPECIAL SERVICE TOOLS

Tool Number	Description
T63L-8620-A	Belt Tension Gauge
T69L-10300-B	Steering Pump Pulley Remover
T65P-3A733-C	Pump Pulley Replacer

CG6349-1B

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GROUP

SUSPENSION 14

SECTION TITLE	PAGE
FRONT SUSPENSION—4-WHEEL DRIVE	14-22-1
FRONT SUSPENSION TWIN-I-BEAM/SOLID-I-BEAM	14-21-1
GENERAL SUSPENSION SERVICE	14-01-1
REAR SUSPENSION—LEAF SPRINGS	14-31-1

SECTION 14-01 General Suspension Service

SUBJECT	PAGE
ADJUSTMENTS	
Camber Adjustment	14-01-12
Camber Adjustment	14-01-13
Caster Adjustment	14-01-14
Caster Adjustment	14-01-14
Caster and Camber Adjustment	14-01-14
Caster and Camber Adjustment	14-01-14
Checking and Adjusting Toe Alignment	14-01-16
Front Wheel Alignment Adjustments	14-01-12
Spindle Arm Adjustments	14-01-17
Steering Stop	14-01-17
Vehicle Lean Correction	14-01-17
DESCRIPTION	
Dog Tracking	14-01-6
DESCRIPTION (Cont'd.)	
Front Wheel Alignment	14-01-2
Front Wheel Alignment Specifications	14-01-3
Toe	14-01-6
DIAGNOSIS GUIDES	14-01-6
INSPECTION	
Front End General Inspection	14-01-9
Front Wheel Bearing End Play Inspection	14-01-10
Shock Absorber Checks	14-01-11
Upper and Lower Ball Joint Inspection	14-01-10
Vehicle Lean Check	14-01-11
SPECIFICATIONS	14-01-18
VEHICLE APPLICATION	14-01-1

VEHICLE APPLICATION

Applies to E-150-E-350, F-150-F-350, Bronco and F-Super Duty Series Vehicles.

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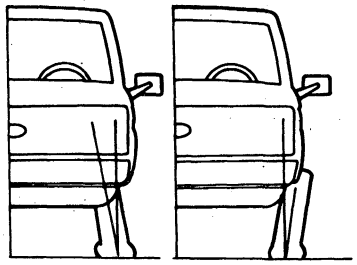
DESCRIPTION

Front Wheel Alignment

Wheel alignment measurements describe the angular orientation of the wheel/tire assembly and the steering axis. Caster, Camber and Toe are the three major, measurable, alignment parameters that most affect tire wear and directional stability. A description of these and other alignment related parameters follow. **It is important to note that the values of these change when a vehicle is loaded and driven. Therefore, the specifications shown in this Section reflect the static measurement of alignment required so that the vehicle will have an alignment when driven that is most favorable for tire wear and directional stability.**

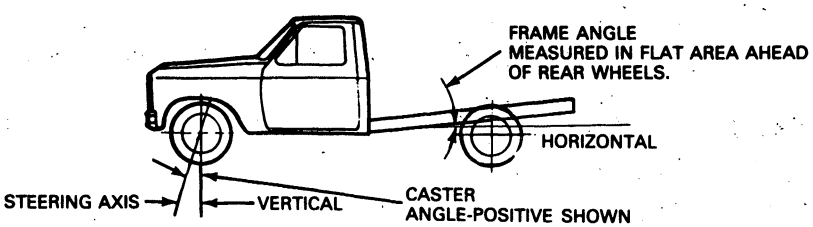
CAMBER

CAMBER IS A TERM USED TO DESCRIBE THE VERTICAL TILT OF THE WHEEL.

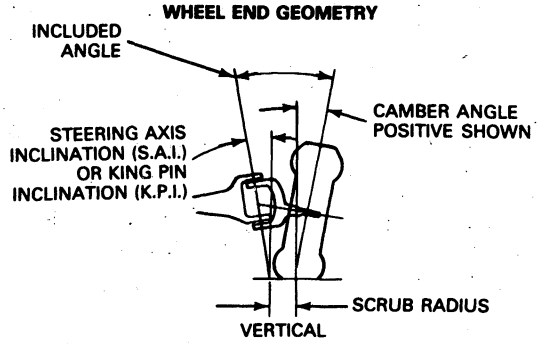


CASTER

CASTER IS A TERM USED TO DESCRIBE THE VERTICAL FORE-AFT TILT OF THE STEERING AXIS. THIS AXIS IS DEFINED BY A LINE DRAWN THROUGH THE CENTERS OF THE SPINDLE BALL JOINTS. RAISING (OR LOWERING) THE REAR, WITHOUT CHANGING FRONT RID HEIGHT, WILL SUBSEQUENTLY DECREASE (OR INCREASE) THE CASTER ANGLE BY THE SAME AMOUNT THE FRAME ANGLE CHANGES.

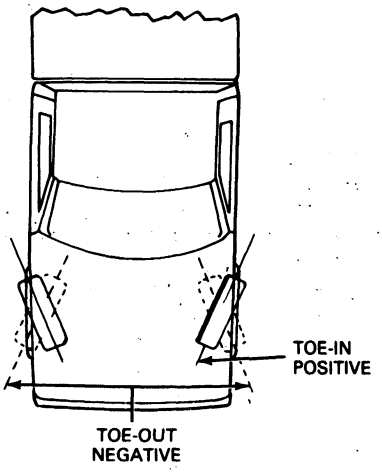


WHEEL END GEOMETRY

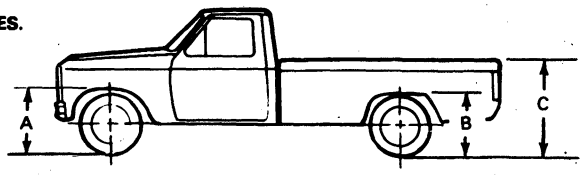


NOTE: INCLUDED ANGLE DOES NOT CHANGE WITH CHANGES IN RIDE HEIGHTS OR FRAME ANGLES.

TOE



SIDE-TO-SIDE LEAN



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DESCRIPTION (Continued)

Front Wheel Alignment Specifications

Vehicles without Aftermarket Modifications

The following reflects vehicle alignments after shipment from the assembly plant and prior to any aftermarket and/or body-builder modifications. Alignment can be checked at any time to help diagnose a problem. Always perform an inspection of the front end components, and repair where necessary, prior to attempting to adjust the alignment to specification. Refer to "Front End General Inspection's.

FRONT WHEEL ALIGNMENT SPECIFICATIONS — VEHICLES WITHOUT AFTERMARKET MODIFICATIONS

Vehicle condition for checking this alignment		• No driver, passengers or cargo • Full Fluids • No aftermarket equipment or body/chassis modifications • All tire sizes comparable to original equipment and set to specified pressure.								
		Front wheel alignment specifications-degs. (inches)								
				Maximum Side-to-Side Difference			Lean (Side-to-Side Height Differences			Dogtrack
Model		Camber	Caster	Camber	Caster	Toe	Front Wheel-House Opening	Rear Wheel-House Opening	Rear End of Pick-Up Box	Centerline of Front Tread to Centerline of Rear Tread
F150	4x2	0.0 to 1.5	1.5 to 4.5	1.0	LH minus RH + 0.7 to − 1.3	(+ 0.3 to − 0.2) (+ 0.16 to − 0.09)	15 mm (5/8 inch)	20 mm (3/4 inch)	20 mm (3/4 inch)	30 mm (1-1/4 inch)
F250 F350	4x2	0.0 to 1.5	1.5 to 4.5							
F150 Bronco	4x4	0.0 to 2.0	1.0 to 4.0							
F250	4x4	0.0 to 2.0	1.5 to 4.5							
F350 Monobeam	4x4	0.0 to 2.0	1.5 to 4.5							
F350 Super Duty Chassis Cab	4x2	0.0 to 2.0	1.5 to 4.5							
E150		0.0 to 2.0	2.5 to 5.5							
E250/350		0.0 to 2.0	1.5 to 5.5							

NOTE: This represents the preferred alignment for optimum tire life and vehicle performance with original equipment tires. CF6652-2A

Vehicle with Aftermarket Modifications

Alignment graphs for Bronco, E-150—E-350 and F-15—F-350 vehicle are provided below to assist in checking caster and camber for various ride heights due to the additional weight from permanently attached aftermarket equipment. THe graphs also show the maximum (or minimum) caster and minimum camber to expect for a vehicle at its minimum ride height. This minimum height is an indication of the maximum weight, of the modified vehicle with passengers and cargo, allowable for the suspension. The GVW and GAWR's for your vehicle may be less due to limitations of other components, such as tire. **Vehicles with alignments beyond these limits of maximum caster and/or minimum camber may be overloaded.**

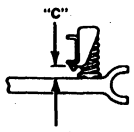
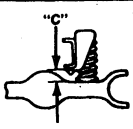
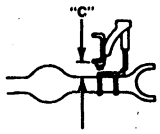
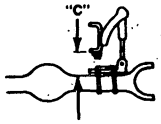
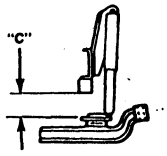
NOTE: The graphs maximums, and minimums reflect the use of "zero" degree caster/camber adjusters at the spindle upper ball joints. Check to see which adjusters have been installed, and their orientation, and interpret the graphs accordingly. The assembly plant sometimes install a different adjuster to control alignment. The change may also be the result of a prior repair.

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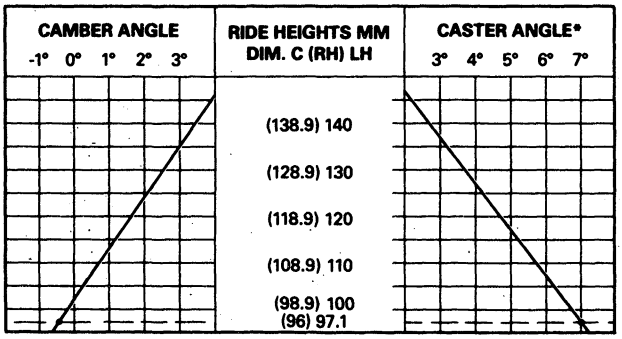
DESCRIPTION (Continued)

FRONT WHEEL ALIGNMENT SPECIFICATIONS — F-150, F-250, F-350 AND BRONCO WITH AFTERMARKET MODIFICATIONS

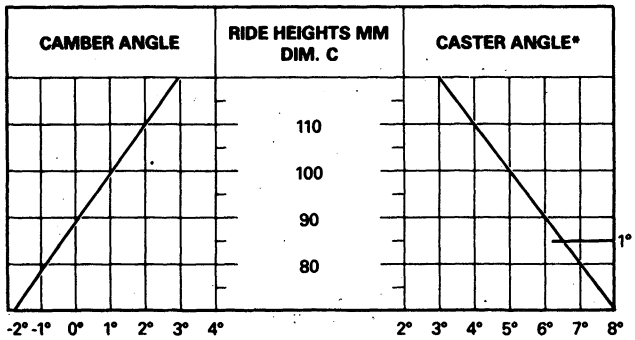
RIDE HEIGHT **NOTE: ALL GRAPHS SHOW ONLY A NOMINAL LINE. THE TOLERANCE AWAY FROM THE LINE IS 1.0 DEGREE**

				
F-150/250/350 (4x2)	**F-150 (4x4) BRONCO**	**F-250 (4x4)**	**F-350 (4x4) MONOBEAM**	**F-SUPER DUTY CHASSIS CAB (4x2)**
BOTTOM OF SPRING TOWER TO TOP OF AXLE MEASURED AT CENTER FRONT FACE OF JOUNCE BUMPER	BOTTOM OF SPRING TOWER TO TOP OF AXLE MEASURED AT OUTBOARD FRONT FACE OF JOUNCE BUMPER	BOTTOM OF FRAME TO TOP OF AXLE	BOTTOM OF METAL JOUNCE STOP TO TOP OF "SPACER-FRONT SPRING PLATE"	BOTTOM OF METAL JOUNCE STOP TO TOP OF SPACER — FRONT SPRING PLATE NOTE: CAMBER ANGLES NOT ADJUSTABLE

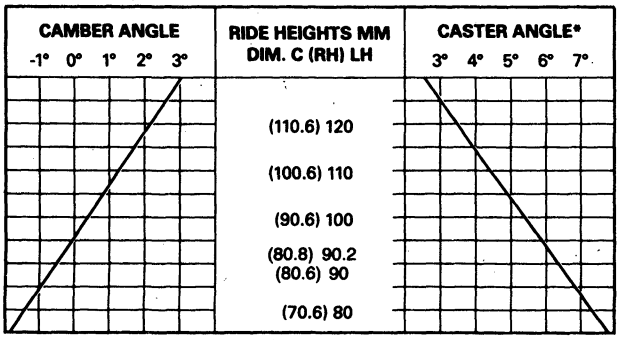
CASTER AND CAMBER ANGLES -- F-150 (4x2)



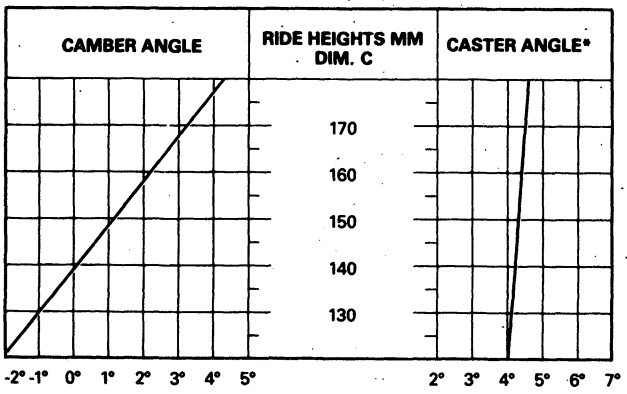
CASTER AND CAMBER ANGLES -- F-150 (4x4) BRONCO



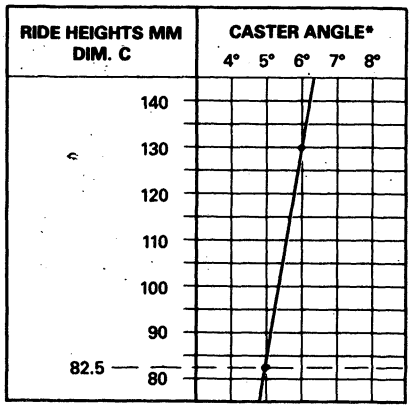
CASTER AND CAMBER ANGLES -- F-250 (4x2)



CASTER AND CAMBER ANGLES -- F-250 (4x4)



F-SUPER DUTY CHASSIS CAB (4x2)



*Caster with Frame Angle

ALIGNMENT AT MAXIMUM VEHICLE WEIGHT

	Maximum Caster (degs.)	Minimum Camber (degs.)
F-150 4x2	7.0	−0.5
F-250 4x2 F-350 4x2	7.25	−0.5
F-150 4x4 Bronco	6	0.0
F-250 4x4	6	0.0
F-Super Duty 4x2 F-350 4x4	6	N.A.

*This reflects vehicles with zero-degree caster/camber adjusters installed.
N.A. — Not Applicable

- For vehicles lower in the front:
  Measured Caster + Frame Angle = Charted Caster
- For vehicles lower in the rear:
  Measured Caster − Frame Angle = Charted Caster

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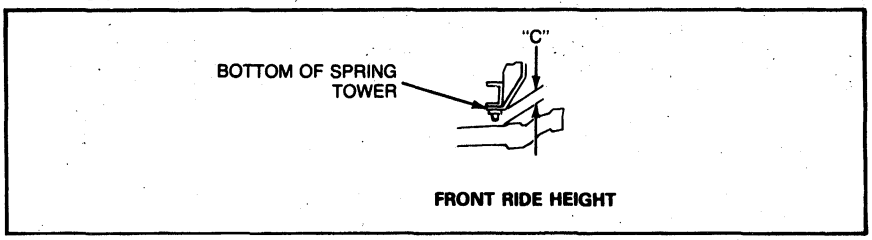
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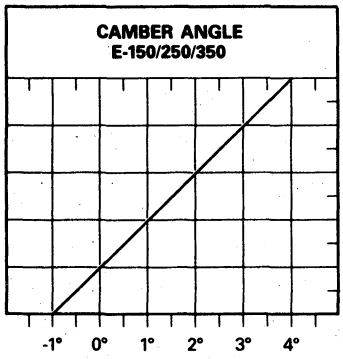
DESCRIPTION (Continued)

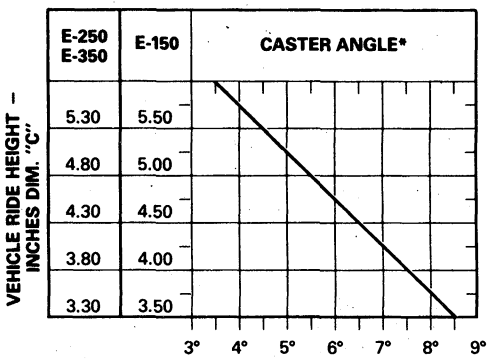
FRONT WHEEL ALIGNMENT SPECIFICATIONS — E-150, E-250, E-350 WITH AFTERMARKET MODIFICATIONS

NOTE: ALL GRAPHS SHOW ONLY A NOMINAL LINE. THE TOLERANCE AWAY FROM THE LINE IS 1.0 DEGREE

RIDE HEIGHT







ALIGNMENT AT MAXIMUM VEHICLE WEIGHT

	Maximum Caster (degs.)	Minimum Camber (degs.)
E-150	8.0	0.0
E-250 E-350	8.0	0.0

*Caster With Frame Angle

- For vehicles lower in the front:
  Measured Caster + Frame Angle = Charted Caster
- For vehicles lower in the rear:
  Measured Caster – Frame Angle = Charted Caster

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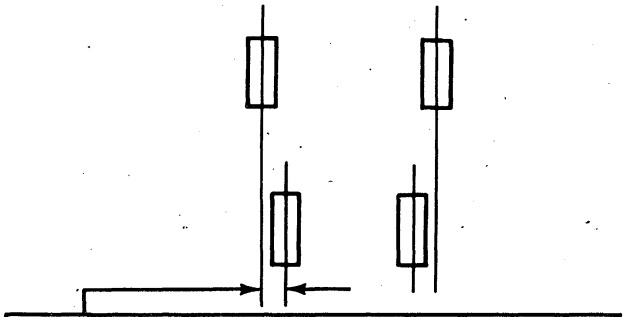
DESCRIPTION (Continued)

Toe

Toe is intended to change slightly with ride height to provide optimum handling and tire life within the vehicle load range limits. It tends to change toward toe-out as the ride height is lowered. If toe is within specification for the vehicle condition described in the specifications under "vehicles without aftermarket modification" there should be no need to readjust toe setting with varying loads. However, if aftermarket equipment that significantly affects the ride height (i.e., snowplow, second unit bodies, tool boxes) is added, the toe may need to be adjusted. Toe should be maintained at the specified setting with the vehicle in the loaded condition that it experiences for more than 50 percent of its use.

Dog Tracking

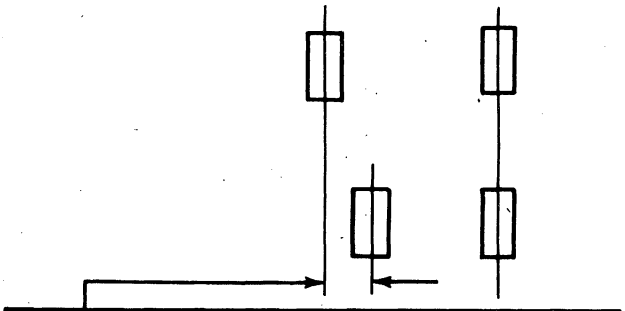
All F-150—F-350 (4x2) (4x), Bronco and E0150—E-350 vehicles with single rear wheels (SRW) have, by design, a front tread that is wider than the rear tread. Front tread is the distance between the two front tires, and likewise for the rear. The illustration below shows these differences.



F-150, Bronco	9 mm (0.35 Inch)
F-250 (4x2) F-350 (4x2)	18 mm (0.71 Inch)
F-250 (4x4) E-150 — E-350	32 mm (1.25 Inch)
F-350 (4x4)	46 mm (1.81 Inch)

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When a vehicle with these tread differences is driven on a crowned road the front may tend to ride higher up the crown than the rear, making these vehicles appear to dogtrack, as illustrated below.



F-150, Bronco	18 mm (0.71 Inch)
F-250 (4x2) F-350 (4x2)	36 mm (1.42 Inch)
F-250 (4x4) E-150 — E-350	64 mm (2.52 Inch)
F-350 (4x4)	92 mm (3.62 Inch)

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DIAGNOSIS GUIDES

Refer to Section 19-01, Roadability, for additional Diagnostic Guides related to alignment.

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DIAGNOSIS GUIDES (Continued)

Refer to Section 19-01, Roadability, for additional Diagnostic Guides related to alignments.

CONDITION	POSSIBLE CAUSE	RESOLUTION
• Vehicle leans to one side	1. Incorrect tire pressure.	1. Assure uniform tire pressure for all tires.
	2. Improper tire/wheel usage.	2. Install correct tire/wheel combination.
	3. Vehicle overloaded or unevenly loaded.	3. Correct as required.
	4. Loose, worn or damaged front or rear suspension components.	4. Visually inspect suspension systems. Repair or replace as required.
	5. Improper spring usage or improperly installed and seated.	5. Correct as required.
	6. Incorrect front axle ride height. • Lateral tilt out of specification (Figs. 3, 4 and 5).	6. To adjust, refer to "Vehicle Lean Correction" in this section.
	7. Incorrect rear axle ride height. • Lateral tilt out of specification (Figs. 3, 4 and 5).	7. To adjust, refer to "Vehicle Lean Correction" in this section.
• Front bottoming or riding low	1. Incorrect tire pressure.	1. Correct as required.
	2. Improper tire/wheel usage.	2. Install correct tire/wheel combination.
	3. Vehicle overloaded or unevenly loaded.	3. Correct as required.
	4. Broken or incorrectly installed front springs.	4. Repair or replace as necessary.
	5. Loose or broken shackles.	5. Tighten or replace as necessary.
	6. Distorted or split jounce bumper.	6. Correct as required.
	7. Incorrect springs.	7. Replace springs.

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DIAGNOSIS GUIDES (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
• Dog tracking of rear wheels	1. Loose or damaged front or rear suspension components.	1. Inspect, repair or replace as required.
	2. Loose rear spring U-bolts.	2. Tighten to specification.
	3. Rear springs improperly installed on axle.	3. Repair as required.
	4. Rear spring center bolt bent.	4. Replace center bolt.
	5. Improperly installed front leaf springs (4x4).	5. Repair as necessary.
• Shimmy or wheel tramp	1. Loose front axle pivot bracket attaching parts.	1. Tighten to specification.
	2. Incorrect tire pressure.	2. Adjust air pressure in tires.
	3. Excessive tire sidewall deflection.	3. Inspect, adjust air pressure and replace as necessary.
	4. Irregular tire wear or tire sizes not uniform.	4. Check front wheel alignment, adjust and replace with same size tires.
	5. Loose wheel lug nuts.	5. Tighten to specifications.
	6. Front wheel bearing adjustment.	6. Adjust to specifications.
	7. Out-of-round wheels.	7. Replace as required.
	8. Out-of-round tires.	8. Replace as required.
	9. Wheel and tire lateral runout not to specifications.	9. Follow tire and wheel runout check — Section 18-01, Noise, Vibration and Harshness Diagnosis.
	10. Incorrect wheel and tire balance.	10. Balance wheels and tires.
	11. Front wheel alignment (toe-in and caster) out-of-specification.	11. Set toe to specifications. Set caster to specifications on vehicles with front leaf springs.
	12. Deteriorated radius arm bushing.	12. Replace.
	13. Loose, worn or damaged shock absorbers.	13. Tighten and replace as necessary.
	14. Loose, worn or damaged steering linkage and idler arm connections.	14. Tighten or replace as necessary.
	15. Broken or sagging springs.	15. Replace as required.
	16. Loose steering gear mounting.	16. Tighten to specifications.
	17. Incorrect steering gear adjustment.	17. Adjust to specifications.
	18. Worn ball joints.	18. Replace ball joints.
	19. Worn spindle (king) pins.	19. Replace spindle pins and spindle pin bushings.

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DIAGNOSIS GUIDES (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
• Sway or roll	1. Unequal load distribution (side-to-side).	1. Correct as necessary.
	2. Excessive load or body height.	2. Correct as necessary.
	3. Incorrect tire pressure.	3. Adjust air pressure in tires.
	4. Loose wheel lug nuts.	4. Tighten to specifications.
	5. Worn or loose stabilizer assembly.	5. Tighten or replace as required.
	6. Broken or sagging spring.	6. Replace as required.
	7. Incorrect steering gear adjustment.	7. Adjust to specifications.
	8. Loose steering gear mounting.	8. Tighten to specifications.
	9. Excessive front or rear overhang.	9. Correct as necessary.
	10. Broken tie bolts on rear spring.	10. Replace as required.

CF3599-2C

INSPECTION

Front End General Inspection

CAUTION: Do not attempt to adjust front wheel alignment without first making a preliminary inspection of the front end parts, and correcting where necessary.

Prior to inspection, fill all fluids to specification. Assure spare tire or wheel, and related equipment are properly stored. Remove all payloads and any excessive accumulation of mud, dirt or road deposits from the chassis and underbody. Inflate all tires to the pressure specified on the Safety Compliance Certification Label (usually located on the inside driver's door pillar). Check both front tires making were they are the same size, ply rating, and load range.

NOTE: Codes identifying the front and rear spring options and springs are printed on the Safety Standard Certification Level. If a spring should require replacement because it is damaged or worn it should be replaced only with the same part as specified on the label. In rare instances, the spring codes will not reflect the springs as installed due to a DSO option or Assembly Plant substitution. If a DSO option number is shown on the certification label, the District Office can establish whether springs are affected. If the factory-installed springs do not agree with the code printed on the Safety Standard Certification Lave (right and left spring part number should match), replace the damaged or worn spring with a new spring of the same part number as the damaged or worn spring. It will not be necessary to replace the matching, non-worn or undamaged spring.

1. Inflate all tires to the specified pressure (cold). Check both front tires. They should be the same size, ply rating and load range.
2. Check for excessive wheel bearing end play. See the procedure in this Section. Adjust and/or replace the wheel bearings as described in the appropriate Section in Group 11.
3. Check for worn or damaged spindle ball joints. Replace the ball joints as described in the appropriate Section in Group 14.
4. Check for bent steering linkage or excessively worn joints. See the appropriate Section in Group 13.
5. Check the steering gear mounting bolts and tighten to the specified torque.
6. Inspect the radius arm to be sure it is not bent or damaged. Inspect the bushings at the radius arm-to-frame attachment for wear and looseness. Repair or replace parts as required.
7. Check other suspension components for damage.
8. Check for aftermarket changes to steering, suspension, wheel and tire components (i.e., competition, heavy duty, etc.). Specifications in this manual do not apply to vehicles with these changes.

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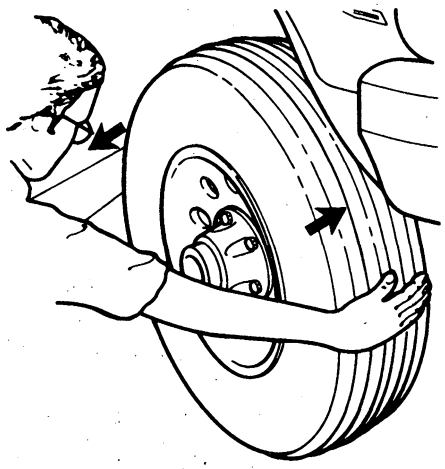
INSPECTION (Continued)

Front Wheel Bearing End Play Inspection

Raise the vehicle until the tire clears the floor.

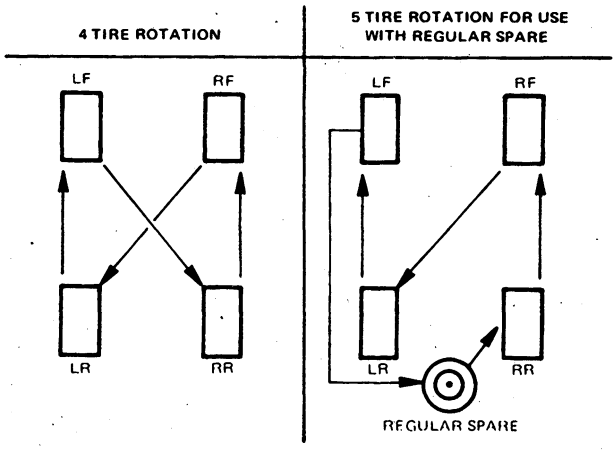
Grasp each front tire at the front and rear and push the wheel inward and outward while lifting the weight of the tire off the bearings. Make sure the wheel rotates freely and that the brake pads are retracted sufficiently to allow movement of the wheel assembly.

If the wheel/hub-rotor is loose on the spindle or does not rotate freely, adjust the wheel bearings as outline in the appropriate Section in Group 11.



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With the vehicle resting on the ground, parking brake fully applied, have someone turn the steering wheel back and forth 360 degrees and watch for relative motion of the studies in the steering linkage ball sockets. Excessive **verticle** motion of the studs relative to the sockets may indicate excessive wear. Also watch for a loose steering gear attachment to the frame. Another method is to raise the front tires off the ground, grasp the tire at the front and rear and watch for excessive play in the joints while trying to watch for excessive play in the joints while trying to steer the wheels. Steel, reusable, joints can be checked for excessive wear by measuring the torque it takes to turn the stud. Remove the tapered stud from its seat and thread the attaching nut back onto the stud. Turn the stud with an in-lbs torque wrench and note the torque to turn the stud. New steel joints will take near 40 in-lbs to turn the stud in the socket. Good, used joints will show 5 to 40 in-lbs and a joint with excessive play will be below 5 in-lbs. Some joints reduce to near 5 in-lbs in the first 1,000 miles of during and stay there for the life of the vehicle. Only replace if it reads below 5 in-lbs.



F3342-1B

Tire Rotation

To equalize tire wear, tires may be rotated, but not until the cause of unusual or uneven tire wear is determined and corrected. TIre rotation is recommended every 8,000-12,000 km (5,000-7,500 miles).

NOTE: Tire tread wears fastest in the first 5,000 miles. Therefore it is very important to perform the first rotation within the specified mileage range to minimize uneven wear.

Upper and Lower Ball Joint Inspection

F-Series Twin I-Bean Front Axle Equipped with Joints

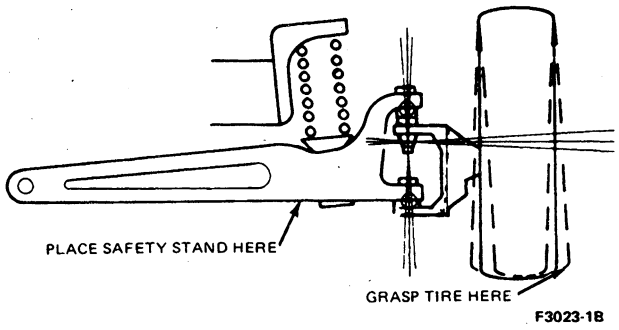
Prior to performing any ball joint inspection, adjust the front wheel bearings as described in the appropriate Section of Group 22, Wheels and Tires.

1. Raise the vehicle and place safety stands under the I-Beam axle beneath the spring as shown below.
2. Have an assistant grasp the lower edge of the tire and move the wheel in and out.
3. While the wheel is being moved, observe the lower spindle arm and the lower part of the axle jaw.
4. A 0.794mm (1/32 inch or greater movement between the lower part of the axle jaw and the lower spindle arm indicated that the lower ball joint must be replaced.

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INSPECTION (Continued)

5. For checking the upper ball joints, grasp the upper edge of the tire and move the wheel in and out. A 0.794mm (1/32 inch) or greater movement between the upper spindle arm and the upper part of the axle jaw indicates that the upper ball joint must be replaced.



Shock Absorber Checks

Both the hydraulic shock absorbers and the low pressure gas shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The low pressure gas shock absorbers are sealed and charged with nitrogen gas to reduce shock absorber fade and improve vehicle ride. The shock absorbers are sealed and charged with nitrogen gas to reduce shock absorber fade and improve vehicle ride. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi) for 1 inch and 1 3/16 inch bore, and 1034 kPa (150 psi) for 1 3/8 inch bore. Do not attempt to open puncture or apply heat to the shock absorbers.

Before replacing a shock absorber, check the action of the shock absorbers as follows:

On Vehicle Tests

1. Check the shock absorber to be sure it is securely and properly installed. Check the shock absorber insulators for damage and wear. Replace any worm or damaged insulators and tighten attachments to the specified torque (on a shock absorber which incorporates internal insulators, replace the shock absorbers). Tighten shock absorber attachments to torque specifications in Specifications Section of each suspension group.
2. Inspect the shock absorber for evidence of fluid leakage. A light film of fluid is permissible. Be sure any fluid observed is not from sources other than the shock absorber.

Replace the shock absorber if leakage is severe.

3. Disconnect the lower end of the shock absorber. Extend and compress the shock absorber as fast as possible, using as much travel as possible. Action should become smooth and uniform throughout each stroke. Higher resistance on extension than on compression is a normal condition. Faint swish noises are also normal. **Ensure that the part number of the replacement is the same as that of the original shock absorber.**

Vehicle Lean Check

F-150—F-250—F-350 (4x2), F-150 (4x4) and Bronco

Side to side vehicle lean should be verified by measuring the fender lip to ground dimension before beginning diagnosis and service actions. Normal acceptable limits are:

- Maximum of 16 mm (5/8 inch) variance between left and right front wheel lips to ground.
- Maximum or 20 mm (3/4 inch) variance between left and right rear wheel lips to ground.

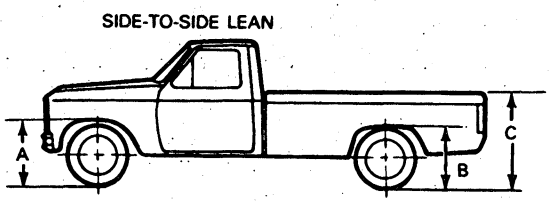
Once a lean condition has been verified, the following procedure should be followed to resolve the condition:

1. Place the vehicle on a flat, smooth surface. Vehicle should be inspected for any heavy add-ons that may cause excessive weight on any corner of the vehicle. Vehicle should be empty, fuel tanks should be full, no cargo in the pick-up box or rear body section of Bronco, such as tools, equipment or debris. Vehicle must be setting on the wheels and tires and not a hoist, jack or jack stands.
2. Check all wheels and tires:
   - Wheels much be same size and design, right and left side on each axle.
   - Wheel size and design, tire size and tire design should be as indicated on the Vehicle Certification Label.
   - Check air pressure of all tires; inflate to specifications indicated on the Vehicle Certification Label.
3. Check front and rear suspension. Make sure the same spring is on the left/right front and left/right rear. The front springs have I.D. Tags indicating the part number. The rear springs have the part number stamped on the bottom just behind the U-bolt attachment.
4. Jounce the vehicle's front and rear suspension to normalize the vehicle static ride height.

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INSPECTION (Continued)

5. Measure the height of the right and left fender lip openings as shown in the specifications charts in the description area of this Section, dimensions A and B, noting dimensions of each and side-to-side differences. If these differences are greater than 16 mm (5/8 inch) between left or right front and/or 19mm (3/4 inch) between left and right rear, adjustment can be performed following the procedure under Adjustments in this Section.



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ADJUSTMENTS

Front Wheel Alignment Adjustments

Refer to the specifications charts in the Description area of this Section.

After front wheel alignment has been checked, make the necessary adjustments as described below.

CAUTION: Do not bend axles or radius arms to change alignment.

Camber Adjustment

E-150—E-250—E-350

Camber is not adjustable on Econoline. The caster angle can be adjusted with the use of a service kit (E5TZ-3K064-A) or equivalent.

This kit includes complete instructions for increasing caster in 1/2 degree increments by installing an adjustment cam on the bottom of the front radius arm. Its intended use is to provide a method to correct side-to-side caster splits. Refer to Section 19-01, Roadability.

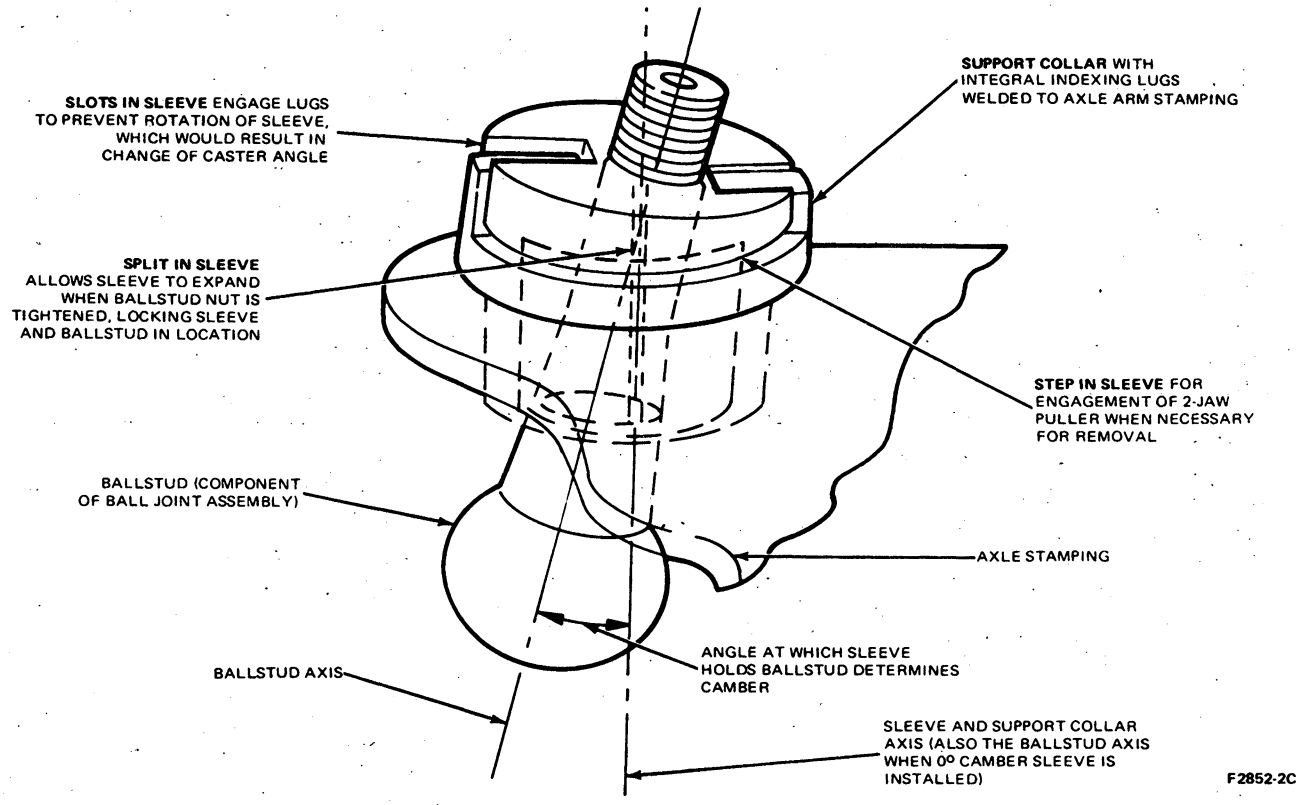
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ADJUSTMENTS (Continued)

Camber Adjustment

Bronco and F-150—F-250 (4x4)

Camber adjustment is provided by means of a series of interchangeable mounting sleeves (camber adjusters) for the upper ball joint stud. Our sleeves are available in 1/2 degree camber increments, providing a 3 degree range of adjustment (from 1-1/2 degree negative to 1-1/2 degree positive)



1. Measure camber with available alignment equipment. If camber is out of specification, proceed to Step 2.
2. Raise vehicle on hoist and remove the front wheels.
3. Remove the upper ball joint cotter pin and nut.
4. Loosen the lower ball joint nut to the end of the stud.
5. Strike the inside of the spindle near the upper and lower ball joints to break the spindle loose from the ball joint studs.
6. Remove the camber adjuster sleeve. If required, use Pitman Arm Puller T64P-3590-F or equivalent to remove the adjuster out of the spindle.
7. Install the replacement service adjuster.
   - To increase camber (more positive) point the arrow on the adjuster outboard.
   - To decrease camber (more negative) point the arrow on the adjuster inboard.
8. Remove the lower ball stud nut and apply Loctite 242 or equivalent to the lower stud.
9. Hand start the lower nut and partially tighten to 54 N·m (40 ft-lb).
10. Install the new upper nut and tighten to 115-135 N·m (85-100 ft-lb). Advance the nut to the next castellation and install a new cotterpin.
11. Finish tightening the lower nut to 128-149 N·m (95-110 ft-lb).
12. Important: Excessive spindle turning efforts, causing poor steering returnability, may result if the fastener tightening sequence described in Steps 8, 9 and 11 are not followed exactly.
13. Reinstall the wheel and lower the vehicle.
14. Check camber and set toe per alignment procedure.

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ADJUSTMENTS (Continued)

Caster Adjustment

Bronco and F-150 (4x4)

Caster is not adjustable on Bronco and F-150 (4x4) vehicles.

Caster Adjustment

F-250 (4x4)

The caster angle on the F-250—F-350 with a leaf spring type suspension can be adjusted by inserting a shim between the spring and axle. Shims are available from Service in 0 degrees, 1 degree and 2 degree increments. The 0 degree shim is used to adjust side to side height.

1. To adjust caster, raise the vehicle and support the front axles on safety stands.

NOTE: If possible, caster adjustment should always be done on the right front axle to avoid changing front driveshaft alignment.

2. Loosen U-bolt nuts and separate spring from axle. Install caster shims between spring and axle. Position the thin edge of the shim towards the front of the vehicle to increase caster, thin edge to the rear to decrease caster.

NOTE: Caster shims installed on the LH axle will change the front driveshaft angle. If a caster shim is used on the LH axle, driveshaft angels must be checked and conform to specifications in Section 15-60, General Driveshaft Service. Always attempt to correct side-to-side caster variations by adjusting the RH axle caster.

Tighten U-bolt nuts until all nuts contact cap. Tighten nuts to 142 N·m (105 ft-lb).

Caster and Camber Adjustment

F-350 (4x4) Monobeam Front Drive Axle and F-Super Duty Monobeam Non-Driving Axle

Caster and camber are not adjustable on F-350 (4x4) or on the F-Super Duty.

Caster and Camber Adjustment

F-150—250—350 4x2 with Ball Joint System

Caster and camber adjustment is possible with service adjusters available in the 1/2 degree, 1 degree, and 1-1/2 degree increments. One adjuster is used to adjust both caster and camber as described below.

1. Measure vehicle caster and camber. Refer to the alignment charts in the Description portion of this section to determine if the vehicle is within specifications. Note any difference between the actual measurements and the specification. This information will be used to select the correct service adjuster.
2. Refer to the chart following this procedure. Using the information from Step 1 select the correct service adjuster. Note the orientation of the slot required to obtain the correct alignment.

Example: If caster and camber together must be reduced 1 degree at the LH wheel, select the 1-1/2 degrees service adjuster and orientate the slot 315 degrees from the straight-ahead position in the vehicle.

If the same adjustment was required for the RH side the orientation would be 255 degrees from the straight-ahead position.

In all cases, select the service adjuster that will bring the alignment into specification with the smallest side-to-side variation (minimize caster and camber splits).

3. Remove the front wheel.
4. Loosen the pinchbolt at the upper ball joint and pry the adjuster out of the axle with the blade of a screwdriver. If required use Pitman Arm Puller T64P-3590-F or equivalent to remove the adjuster.
5. Install the new service adjuster. Orientate the slot as specified in the following chart. A 1-1/2 inch socket may be used to rotate the adjuster into position.
6. Tighten the pinchbolt to 67-88 N·m (50-65 ft-lbs).
7. Install the front wheel.
8. Check alignment and reset toe to specification.

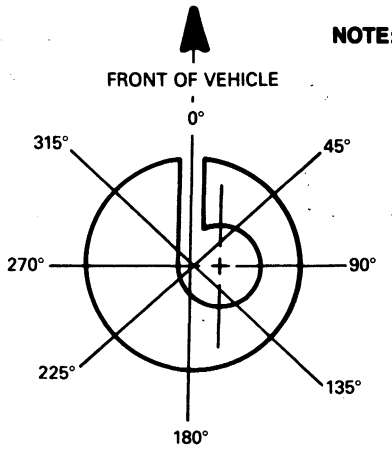
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ADJUSTMENTS (Continued)

F-SERIES 4x2 ADJUSTABLE CAMBER/CASTER

Service Adjuster Type (Degrees)	Position Slot in Axle (Degrees)	LH Axle		RH Axle	
		Camber Change (Degrees)	Caster Change (Degrees)	Camber Change (Degrees)	Caster Change (Degrees)
1/2	0	−0.5	0	+0.5	0
1	0	−1.0	0	+1.0	0
1-1/2	0	−1.5	0	+1.5	0
1/2	45	−0.25	+0.25	+0.25	+0.25
1	45	−0.75	+0.75	+0.75	+0.75
1-1/2	45	−1.00	+1.00	+1.00	+1.00
1/2	90	0	+0.5	0	+0.5
1	90	0	+1.0	0	+1.0
1-1/2	90	0	+1.5	0	+1.5
1/2	135	+0.25	+0.25	−0.25	+0.25
1	135	+0.75	+0.75	−0.75	+0.75
1-1/2	135	+1.00	+1.00	−1.00	+1.00
1/2	180	+0.5	0	−0.5	0
1	180	+1.0	0	−1.0	0
1-1/2	180	+1.5	0	−1.5	0
1/2	225	+0.25	−0.25	−0.25	−0.25
1	225	+0.75	−0.75	−0.75	−0.75
1-1/2	225	+1.00	−1.00	−1.00	−1.00
1/2	270	0	−0.5	0	−0.5
1	270	0	−1.0	0	−1.0
1-1/2	270	0	−1.5	0	−1.5
1/2	315	−0.25	−0.25	+0.25	−0.25
1	315	−0.75	−0.75	+0.75	−0.75
1-1/2	315	−1.00	−1.00	+1.00	−1.00

NOTE: The hole is centered on a zero-degree adjuster — not offset as shown.



TOP VIEW OF CAMBER/CASTER ADJUSTER
(POSITION SLOT IN AXLE TO OBTAIN DESIRED ALIGNMENT)

NOTE: The assembly plant sometimes builds vehicles with adjusters that are not zero-degree type to control alignment. This table shows the alignment changes that will occur if the vehicle was originally built with zero-degree adjusters. Always check to see which adjuster has been installed (and it's orientation) before making changes.

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ADJUSTMENTS (Continued)

Checking and Adjusting Toe Alignment

Refer to toe specifications for F-150—F-250—F-350 and Bronco and E-150—E-250—E-350 in the Description area of this Section.

Clear Vision is a term used to describe a level or well centered steering wheel.

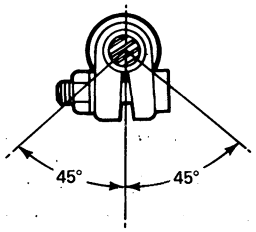
The F-Series and Econoline steering linkage has adjustments in both the tie road and the drag link. First, remove the horn pad and insure that the steering wheel is properly installed as described in Section 13-06, Steering Column—Shift Rod. If correct, turn steering wheel from stop to stop to determine the center position. Return the steering wheel to the center position and lock in place using a steering wheel holder. With steering wheel locked in place, set toe to correct specification.

1. Loosen the clamp bolts for the adjusting sleeve at each end of the toad and link assembly connecting to the spindles.
2. Rotate the sleeve until the correct toe alignment is obtained.
3. With the clamps 4.76mm (3/16 inch) from the end of the sleeve on (4x4) models and centered between the adjustment sleeve lock ring nibbs on F-150—F-250—F-350 and F-Super Duty (4x2) and E-150—E-250—E-350 models, position the bolts as shown below.

NOTE: Lubricate clamp fasteners prior to tightening.

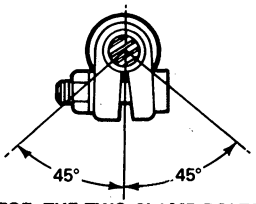
4. Recheck the toe alignment to make sure no changes occurred as the clamp nuts were tightened.

E-150 – E-250 – E-350



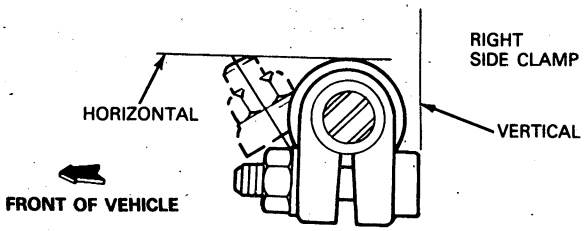
AFTER SETTING TOE, THE TWO CLAMP BOLTS/NUTS ON THE ADJUSTING SLEEVE MUST BE POSITIONED WITHIN A LIMIT OF 45 DEGREES (PLUS/MINUS) AS SHOWN WITH THE THREADED END OF THE BOLTS POINTING DOWN.

F-150 – F-250 – F-350 – F-SUPER DUTY AND BRONCO

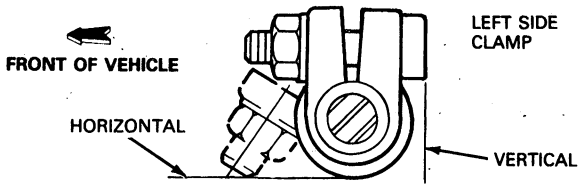


AFTER SETTING TOE, THE TWO CLAMP BOLTS/NUTS ON EACH ADJUSTING SLEEVE MUST BE POSITIONED WITHIN A LIMIT OF 45 DEGREES (PLUS/MINUS) AS SHOWN WITH THE THREADED END OF THE BOLTS ON THE LEFT HAND SLEEVE POINTING TOWARDS THE FRONT OF THE VEHICLE AND THE THREADED END OF THE BOLTS ON THE RIGHT HAND SLEEVE FACING REARWARD.

F-SUPER DUTY



AFTER SETTING TOE, THE CLAMP BOLT/NUT ON THE RIGHT (TIE ROD) ADJUSTING SLEEVE MUST BE POSITIONED WITHIN A LIMIT OF 45 DEGREES (PLUS/MINUS) AS SHOWN WITH THE THREADED END OF THE BOLT POINTING FORWARD.



AFTER SETTING TOE, THE CLAMP BOLT/NUT ON THE LEFT (DRAG LINK) ADJUSTING SLEEVE MUST BE POSITIONED WITHIN A LIMIT OF 45 DEGREES (PLUS/MINUS) AS SHOWN WITH THE THREADED END OF THE BOLT POINTING FORWARD.

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ADJUSTMENTS (Continued)

Steering Stop

All F-150—F-250—F-350 (4x2) and F-Super Duty and E-150—E-250—E-350 models have built in steering stops which cannot be altered. E-250-E-350 models have non-adjustable steering stop pins which are pressed into the axle. These stop pins are matched to tire size and nay necessitate replacement with different length stop pins if the tire size is changed.

F-150—F-250—F-350 (4x4) models use a welded in screw and locknut which is not adjustable. A spacer cap is used with wide tread tires on F-150 (4x4).

Spindle Arm Adjustments

The chart below shows the degree position of the front wheels when checking the stop adjustment angles.

Vehicle Type	Spindle Arm Stop Angle — Degrees*	
	Kingpin	Ball Joint
F-150 (4x2) Regular & Super Cab	36.8	36.8
F-250/350 (4x2) Regular Cab, Super Cab and Crew Cab	35.0	35.0
F-150 (4x4) Regular Cab, Super Cab and Bronco	—	36.0①
F-250 (4x4) Regular Cab, Super Cab and Crew Cab	—	33.4
F-350 (4x4) Regular Cab, F-250 HD (4x4)	—	30.3

*All stops are non-adjustable.
①34.0 with 10x15 size tires. CF2364-1J

Vehicle Lean Correction

Front Lean

Measure the LH and RH front wheelhouse openings to ground as depicted in the Vehicle Lean Check portion of this Section. Refer to the Vehicle Lean Test portion of this Section for the specified limits on their side-to-side difference or lateral tilt. A vehicle within these limits would not have an objectionable lean appearance. However, if the lean is objectionable perform the following to adjust:

- Vehicles with *coil springs:*

If the side-to-side difference is less than 19mm (3/4 inch) install a 6.35mm (1/4 inch) Service Shim (P/N 389117-S2) under the lower spring seat on the low side. No more than one shim is to be added.

If there is a side-to-side difference of 19mm (3/4 inch) or more remove the high side spring from the vehicle and compare it with a service replacement part having the same part number.

If the free height of the original equipment spring exceeds the free height of the service part by 13mm (1/2 inch), install the service part in this location. If the free height of the original spring is less by at least 13mm (1/2 inch), remove the low side spring. Compare the service spring to both of the original sprints and select the two springs most evenly matched. Install the higher spring at the low side.

- Vehicles with front leaf springs.

A service shim is available that installs between the spring and the axle.

Rear Lean

A side-to-side lean at the rear of the vehicle can be adjusted by approximately 10mm (3/8 inch) by installing a shim between the rear spring and axle on the low side of the vehicle. A "low at the rear" vehicle can be raised approximately 10mm (3/8 inch) by installation of one shim on each side. Use the following procedure to install the shim (D7TZ-5742-AZ):

1. Raise the vehicle frame until the with is off the rear springs but with the tires still touching the floor.
2. Loosen the spring U-bolts to allow the axle to separate from the spring approximately 13mm (1/2 inch).
3. Position the shim (D7TZ-5742-AZ) between the spring and the spring seat and with the tie bolt head through the hole in the shim. On 4x4 vehicles, position the shim between the rear spring and axle spacer. Tape may be used to hold the shim in position.
4. Assure that the spring leaves are properly aligned and the spring U-bolts contact the edges of the spring assembly or axle seat.
5. Tighten the spring U-bolt sufficiently to assure that the spring tie bolt head that extends through the shim enters the hole in the axle seat.
6. Tighten U-bolt nuts to 102-135 N·m (75-100 ft-lbs) on F-150 (4x2 and 4x4)/Bronco and E-150—E-250—E-350 and to 204-282 N·m (150-210 ft-lbs) on F- 250—F-350 (4x2) and E-250—E-350.

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
D81T-3010-B	Ball Joint Removing Tool	F-150 (4x2) with Stamped Twin I-Beam Axles — Removal of Camber Adjusting Sleeve
T80T-3010-A	Ball Joint Tool	F-150-F-350 (4x4), Bronco Upper and Lower Ball Joints
D79P-3283-A	Tie Rod Adjustment Tool	Universal
TOOL-3290-D	Tie Rod End Remover	Universal
T64P-3590-F	Pitman Arm Puller	Universal
T78P-5638-A	Suspension Bushing Service Set	6.75" and 7.5" 4-Bar Rear Axle Vehicles
T80T-5638-A	Front Suspension Bushing Tool	Front Drive Axle Suspension.Bushing Removal and Installation

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SECTION 14-21 Front Suspension Twin-I-Beam/Solid-I-Beam

SUBJECT	PAGE
ADJUSTMENTS	
Camber Adjustment	14-21-3
DESCRIPTION	
Front Axle	14-21-1
Front Shock Absorber	14-21-1
Front Stabilizer Bar—F-150—F-350 (4x2), F-Super Duty Series and Econoline	14-21-3
Front Suspension	14-21-1
Tracking Bar	14-21-1
REMOVAL AND INSTALLATION	
Axle Pivot Bracket (Right Side)	14-21-14
F-150—F-250—F-350 (4x2)	14-21-14
Axle Pivot Bushing	14-21-12
Camber Adjuster—F-150—F-350 (4x2) with Ball Joints	14-21-11
Front Axle	14-21-17
Front Shock Absorber	14-21-4
E-150—E-250—E-350	14-21-4
F-150—F-250—F-350	14-21-7

SUBJECT	PAGE
REMOVAL AND INSTALLATION (Cont'd)	
Front Spring	14-21-3
Front Stabilizer Bar	14-21-14
Front Twin-I-Beam Axle	14-21-16
Front Wheel Spindle	14-21-8
E-150—E-250—E-350 and F-Super Duty Series Vehicles	14-21-8
Front Wheel Spindle—F-150—F-350 (4x2) with Ball Joints	14-21-9
Jounce Bumper	14-21-13
Radius Arm	14-21-12
Radius Arm Rear Bracket—E-150-E-250-E-350	14-21-13
Spindle Bushing—Bronze	14-21-17
Track Bar	14-21-16
Upper and Lower Ball Joints—F-150—F-350 (4x2) with Ball Joints	14-21-11
SPECIFICATIONS	14-21-24
VEHICLE APPLICATION	14-21-1

VEHICLE APPLICATION

F-150 Through F-350 (4x2), E-150 Through E-350 and F-Super Duty Chassis Cab, Commercial Stripped Chassis and Motor Home Chassis Vehicles.

DESCRIPTION

Front Suspension

The F-150—F-250—F-350 (4x2) and E-150—E-350 vehicles use coil springs with the two I-beam type front axles. The springs are mounted between the frame spring pocket and the axle, (Figs. 1 and 2).

The F-Super Duty Chassis Cab vehicle uses two leaf springs attached to a solid I-beam front axle. The springs are mounted to the front axle with U-bolts and are attached to the frame side rails using a "fixed" bracket at the rear and a moveable shackle at the front. (Fig. 3)

F-Super Duty Commercial Stripped Chassis and Motor Home Chassis Vehicles use two leaf springs attached to a solid I-beam front axle. The springs are attached to the frame side rails using a "fixed" bracket at the front and a moveable shackle at the rear (Fig. 6).

Front Axle

The F-150—F-250—F-350 (4x2) and E-150—E-250—E-350 vehicles use two I-beam type front axles (one for each front wheel). One end of each axle is attached to the spindle and a radius arm, and the other end is attached to a frame pivot bracket on the opposite side of the vehicle.

F-Super Duty series vehicles use a solid I-beam type front axle and is attached by two leaf springs to both frame side rails. The springs are mounted to the axle by U-bolts.

Each spindle is held in place on the axle by ball joints (F-150—F-350 4x2) on I-Beam axles or a spindle pin (kingpin) (E-150—E-350 and F-Super Duty Series) which pivots in bronze bushings pressed in the upper and lower ends of the spindle on forged I-Beam axles. A thrust bearing is installed between the lower end of the axle and the spindle to support the load on the axle. All vehicles (except F-Super Duty Stripped Chassis and Motor Home Chassis Vehicles) have a steering arm which is an integral part of the spindle (Figs. 1 and 2).

Tracking Bar

On the F-Super Duty Chassis Cab vehicles, a tracking bar is attached to the left hand side of the # 1 crossmember and to the right hand side of the axle I-beam inboard of the right hand spring pad.

Front Shock Absorber

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

The hydraulic shock absorbers and the low pressure gas shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both on compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The low pressure gas shock absorbers are sealed and charged with nitrogen gas to reduce shock absorber fade and improve vehicle ride. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

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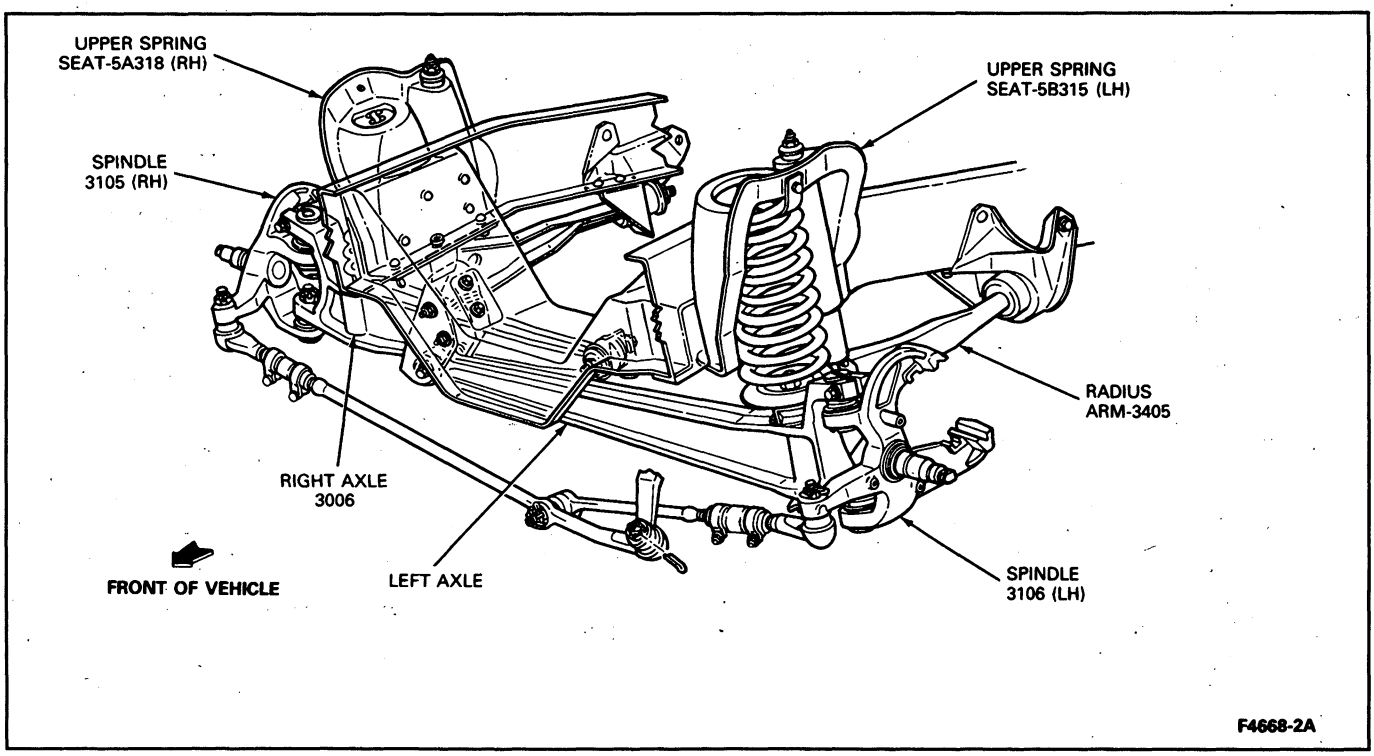


FIG. 1 Front Suspension—Twin I-Beam Axle equipped with Ball Joints—F-150—F-250—F-350 (4x2)

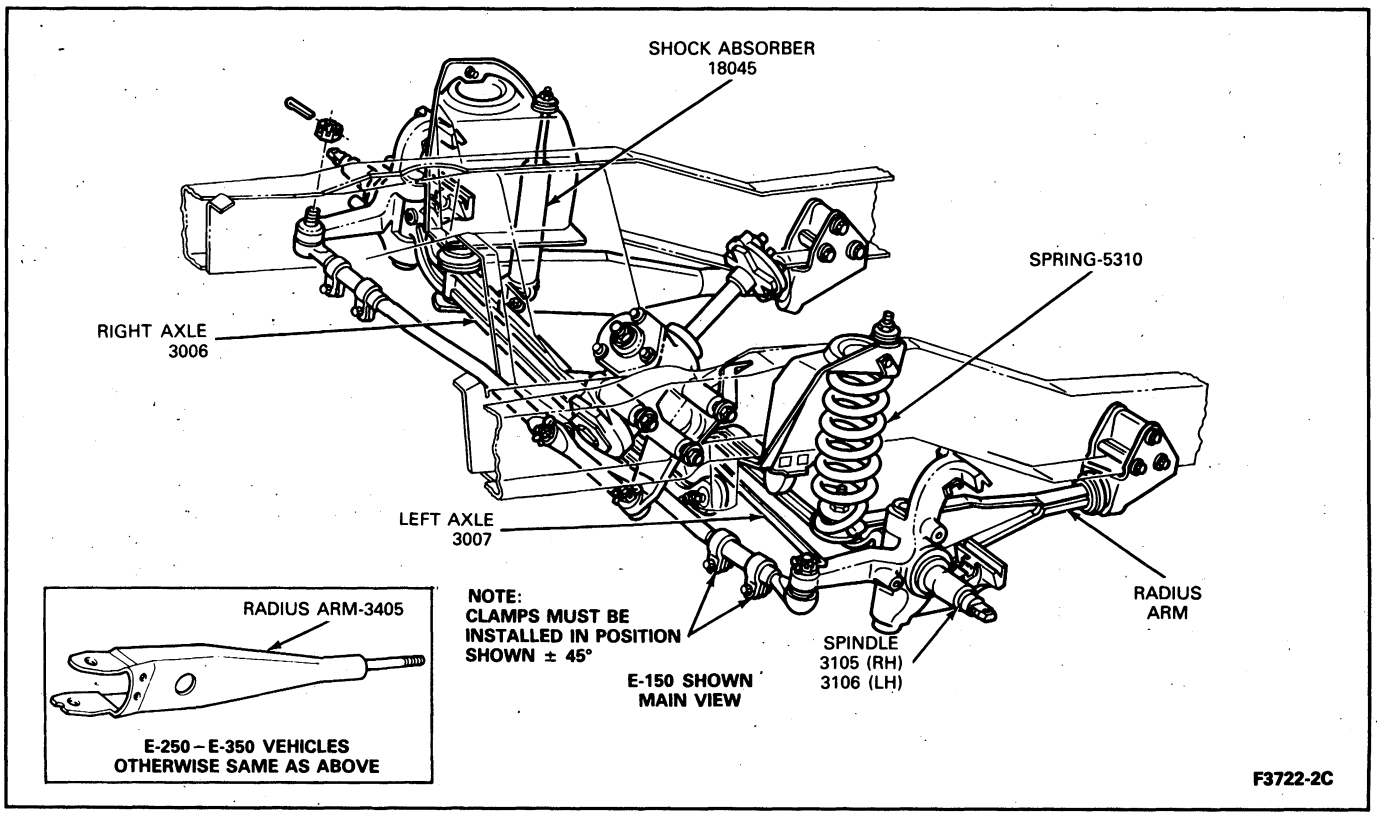


FIG. 2 Front Suspension—Twin I-Beam Axle equipped with Spindle Pins—E-150—E-250—E-350

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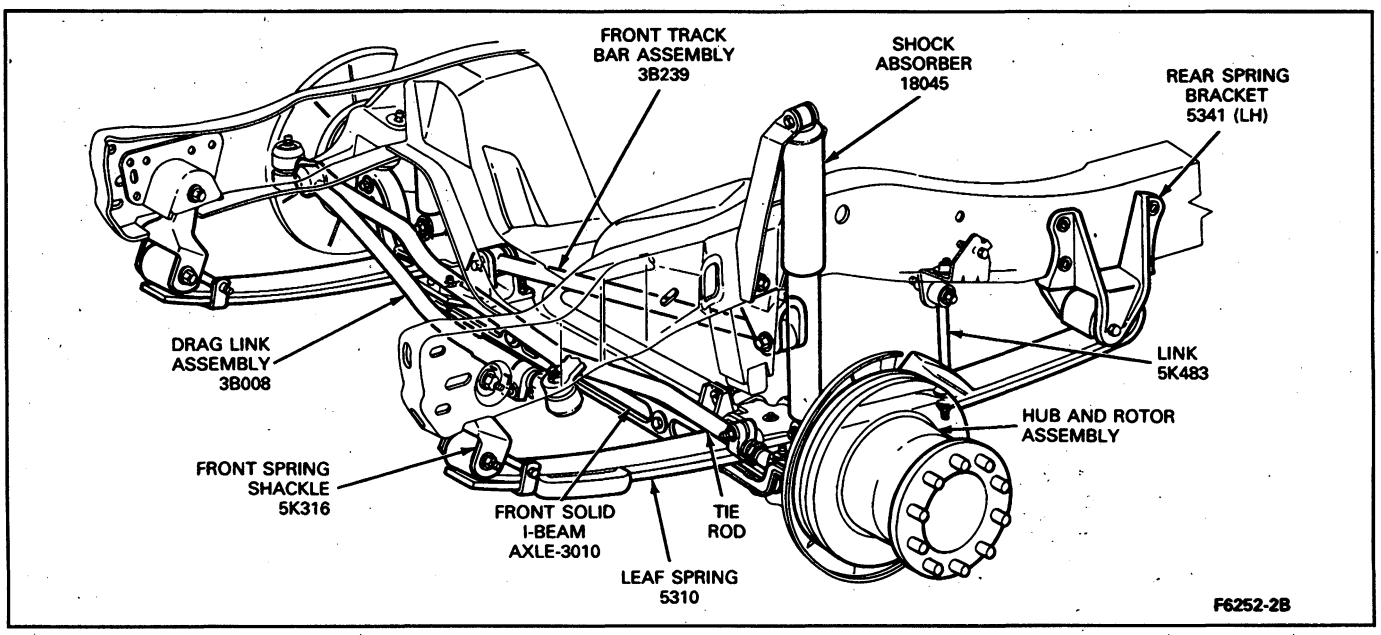


FIG. 3 Front Suspension—Solid-I-Beam Axle Equipped with Spindle Pins and Leaf Springs—F-Super Duty Chassis Cab

Front Stabilizer Bar—F-150—F-350 (4x2), F-Super Duty Series and Econoline

The front stabilizer bar is located forward of the front axle and is attached to the I-Beam through a rubber insulated link assembly. Stabilization is acquired through torque loads transmitted to the frame side rails through the stabilizer bar assembly. Refer to Figs. 25, 26 and 27. F-Super Duty Chassis Cab—The front stabilizer bar on these vehicles is attached to the rear of the axle beam, and is connected to each frame side rail by insulated link assemblies (Fig. 28).

ADJUSTMENTS

Camber Adjustment

Only F-150—F-350 vehicles equipped with ball joints can have the camber setting adjusted. Camber is adjusted by replacing the camber adjuster on the upper ball joint stud. Adjusters are available in 0 degrees, 1/2 degrees, 1 degrees and 1 1/2 degrees increments.

NOTE: On F-Super Duty series vehicles, do not attempt to change the camber by bending the axle beam. Camber angle is not adjustable.

If camber needs adjustment, replace the camber adjuster as described in this Section under camber adjuster—Removal and Installation.

REMOVAL AND INSTALLATION

Front Spring

F-150—F-350 (4x2) and E-150—E-350

Refer to Figs. 4 and 7.

Removal

1. Raise the front of the vehicle and place safety stands under the frame and a jack under the axle. Refer to Section 50-04, Hoisting and Jacking Light-Medium-Heavy, Pre-Delivery manual, for hoisting instructions.

   NOTE: The axle must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the disc brake caliper must be removed from the spindle according to the procedures specified in Section 12-24. Disc Brakes—Light and Heavy Duty—Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the brake hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.
2. Disconnect the shock absorber from the lower bracket.
3. Remove the spring upper retainer attaching bolts or screws from the top of the spring upper seat and remove the retainer.
4. Remove the nut attaching the spring lower retainer to the lower seat and lower rubber insulator and axle and remove the retainer.
5. Slowly lower the axle and remove the spring.

Installation

1. Place the spring in position and slowly raise the front axle.
2. Position the spring lower retainer over the stud, lower rubber insulator (if so equipped) and lower seat, and install the attaching nut.
3. Position the upper retainer over the spring coil and against the spring upper seat, and install the attaching screw.
4. Tighten the upper retainer attaching bolt and lower retainer attaching nut to specifications which follow:

   F-150 (4x2)

   - Upper Retainer, 18-24 N·m (13-18 ft-lbs)

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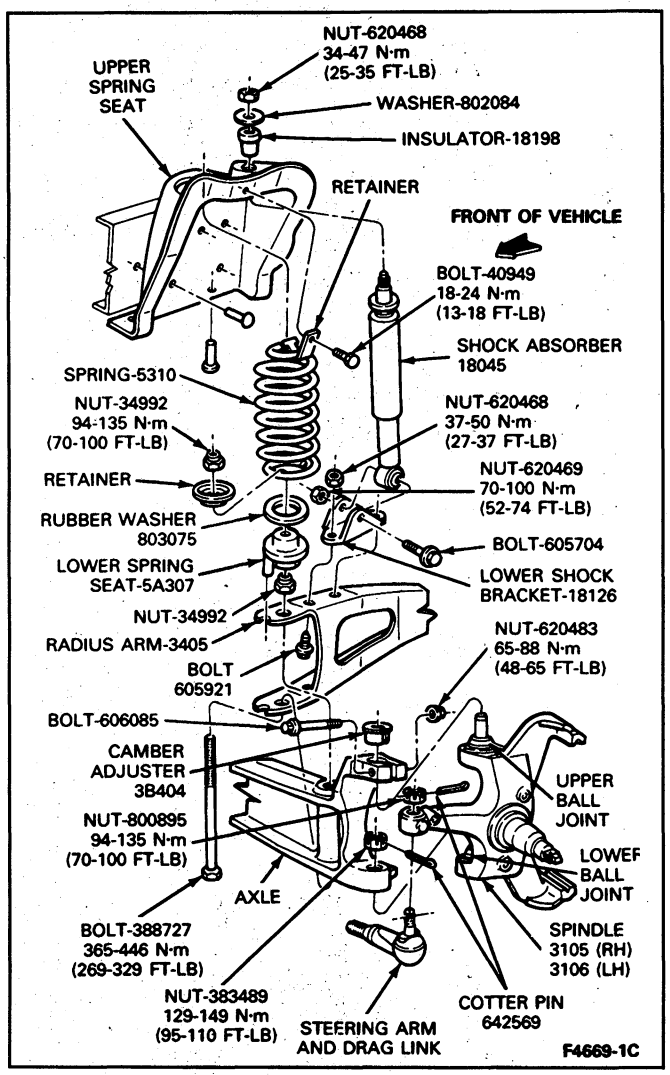


FIG. 4 Front Spring and Shock Absorber Installation—F-150—F-350 (4x2) with Ball Joints

- Lower Retainer, 95-135 N·m (70-100 ft-lbs)

F-250—F-350 (4x2)

- Upper Retainer, 18-24 N·m (13-18 ft-lbs)
- Lower Retainer, 95-135 N·m (70-100 ft-lbs)

E-150—E-250—E-350

- Upper Retainer 28-40 N·m (20-30 ft-lbs)
- Lower Retainer 95-135 N·m (70-100 ft-lbs)

5. Connect the shock absorber to the lower bracket. Install the lower bolt with head towards the tire and tighten nut as follows: E150/250/350 55-81 N·m (40-60 ft-lbs); F150/250/350 70-100 N·m (52-74 ft-lbs).
6. Remove the jack and safety stands.

Front Spring

F-Super Duty Chassis Cab, Commercial Stripped Chassis and Motor Home Chassis Vehicles

Refer to Figs. 5 and 6.

Removal

1. Raise the vehicle frame until the weight is off the front springs with the wheels still touching the floor.
2. Support the front axle with jacks to remove the weight from the spring U-bolts.
3. Remove the nut and washer that holds the shock absorber to the spring spacer. Disconnect the shock absorber from the spring spacer.
4. Remove the nut and bolt that retains the spring to the front spring shackle.
5. Remove the nut and bolt that retains the spring to the rear spring shackle.
6. Remove the four U-bolt nuts. Remove the jack bracket or stabilizer bar bracket. Remove the U-bolts.
7. Remove the spring from the vehicle.

Installation

1. Position the spring at the spring seat on the front axle and align the spring eye with its mating hole in the front spring shackle.
2. Prior to installation, coat the bushing with Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Gently guide the bolt through the shackle and spring eye.
3. Install the retaining nut. Tighten to specification.
4. Align the rear spring eye with its mating hole in the rear spring shackle.
5. Coat the bushing with Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Gently guide the bolt through the shackle and spring eye. Install the retaining nut. Tighten to 203-285 N·m (150-210 ft-lbs).
6. Position the spring spacer on the locating boss in the spring.
7. Install the U-bolts. Install the jack bracket or stabilizer bar bracket on the forward U-bolt. Install the four U-bolt nuts and tighten to 203-285 N·m (150-210 ft-lbs).
8. Install shock to spring spacer. Install the nut and washer that holds the shock absorber to the spring spacer and tighten to specifications.
9. Remove the jacks from under the front axle.
10. Lower the vehicle.

Front Shock Absorber

E-150—E-250—E-350

Refer to Fig. 7.

CAUTION: The low pressure gas shock absorbers are charged with Nitrogen gas to 931 kPa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Insert a wrench from the rear side of the spring upper seat to hold the shock absorber upper retaining nut. Loosen the stud by turning the hex provided on the exposed (lower) part of the stud and remove the nut.
2. Disconnect the lower end of the shock absorber from the lower bracket (bolt and nut).
3. Remove the shock absorber, washers and rubber insulators.

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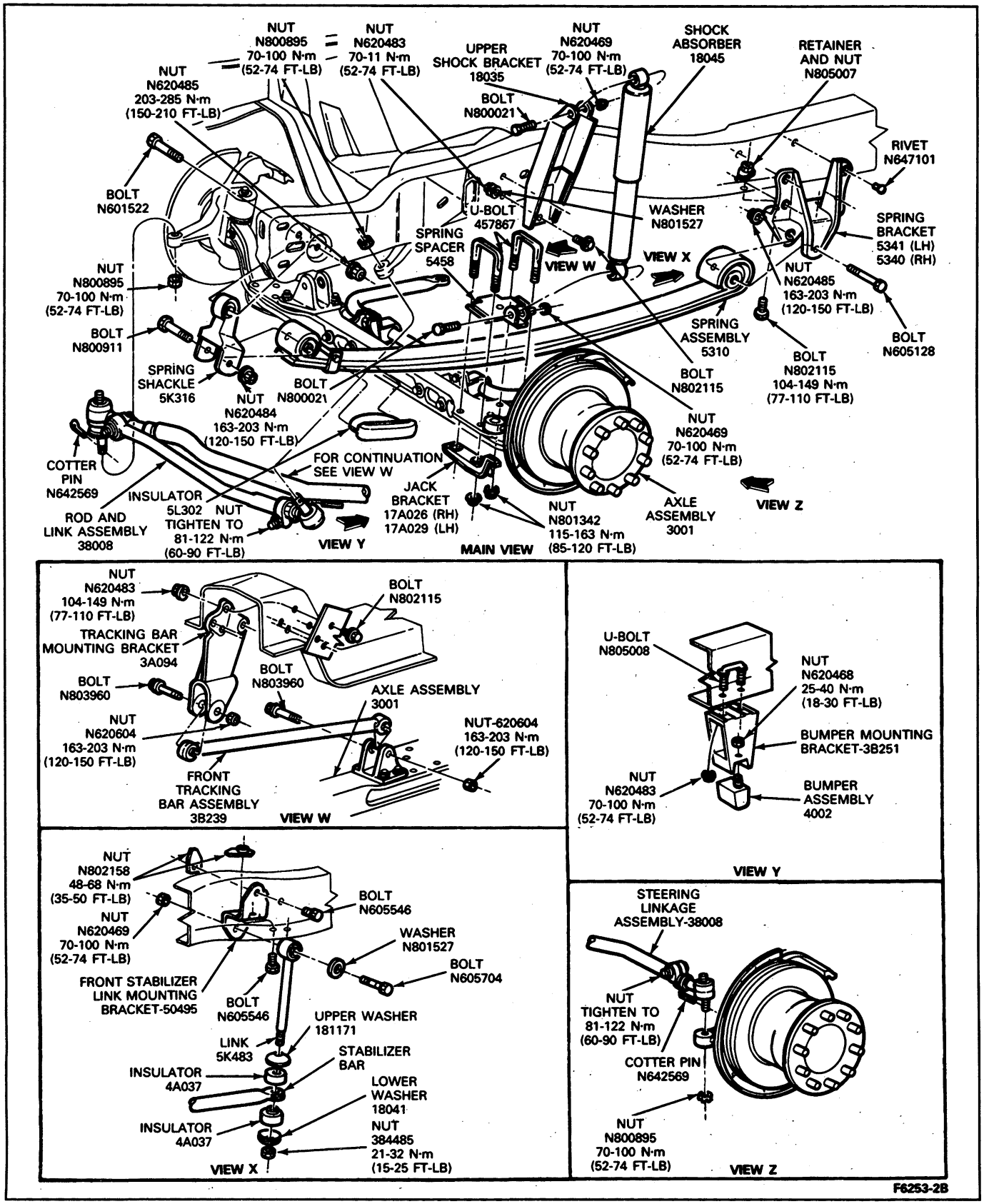


FIG. 5 Front Spring, Shock Absorber and Tracking Bar Installation—F-Super Duty Chassis Cab

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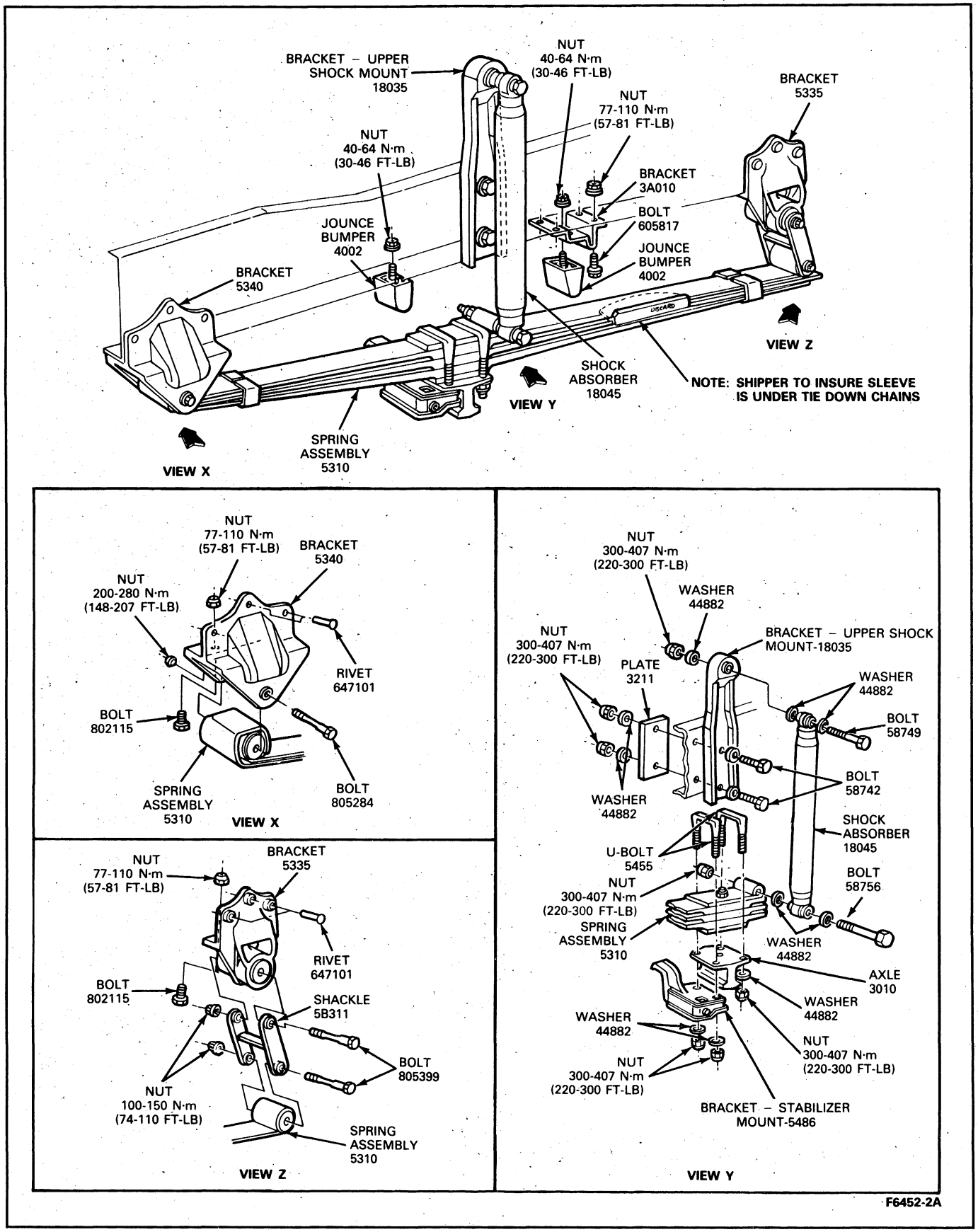


FIG. 6 Front Spring and Shock Absorber Installation—F-Super Duty Commercial Stripped Chassis and Motor Home Chassis Vehicles

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Installation

1. When installing a new shock absorber, use new rubber insulators. Install the lower washer and insulator on the stud end, and position the shock absorber in the spring upper seat. Install the upper insulator, washer and self-locking nut. While holding the nut as described in Step 1 of Removal, tighten to 25-37 N·m (18-28 ft-lbs) by turning the hex provided on the stud.
2. Connect the lower end of the shock absorber to the lower bracket by installing the bolt and nut. Tighten to 55-81 N·m (40-60 ft-lbs).

Front Shock Absorber

F-150—F-250—F-350

Refer to Fig. 4.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Insert a wrench from the rear side of the upper spring seat to hold the shock absorber retaining nut in place. Loosen the stud by turning the hex provided on the exposed (lower) part of the stud and remove the nut and washer.
2. Disconnect the lower end of the shock absorber from the lower bracket by removing the nut and bolt.
3. Compress the shock absorber and remove it from the vehicle.
4. Cut out the insulator from the upper spring seat.

Installation

1. Coat the upper spring seat with a soap solution and install a new one-piece insulator in the seat.
2. Insert the upper shock absorber stud through the insulator. Install the steel washer and hand start the nut. Insert a wrench from the rear of the upper spring seat to hold the upper nut stationary. Tighten the hex on the shock absorber to 34-47 N·m (25-35 ft-lbs) N·m (25-35 ft-lbs).
4. Position the shock absorber in the lower bracket. Install the bolt so the bolt head faces the tire. Install the nut and tighten to 70-100 N·m (52-74 ft-lbs).

Front Shock Absorber

F-Super Duty Chassis Cab, Commercial Stripped Chassis and Motor Home Chassis Vehicles

Refer to Figs. 5 and 6.

Removal

1. Remove the nut and bolt that retains the shock absorber to the upper shock bracket.
2. Remove the nut and bolt that retains the shock absorber to the eyes on the spring spacer.
3. Remove the shock absorber from the vehicle.

Installation

1. Position the shock absorber in the upper shock bracket. Install the nut and bolt and tighten to specification.

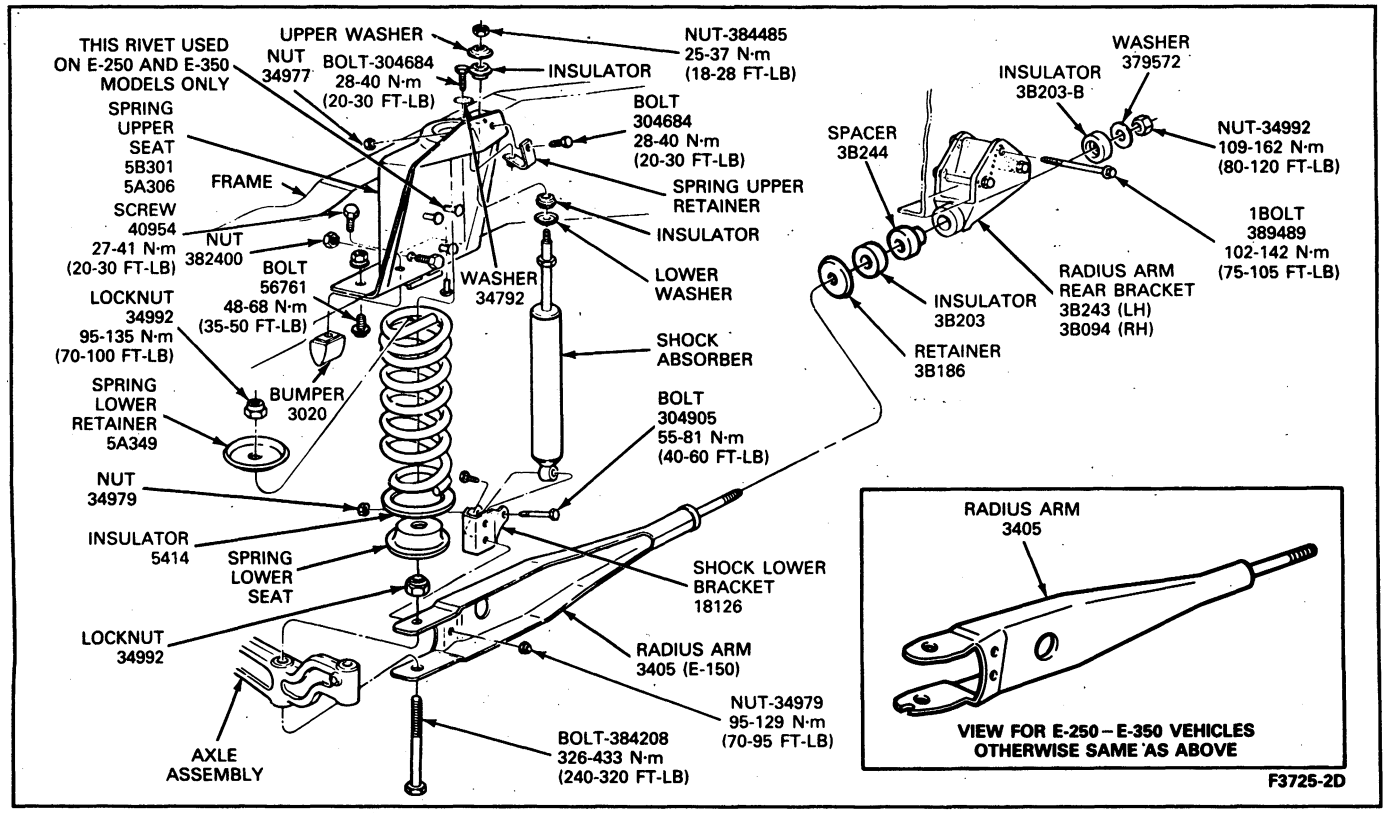


FIG. 7 Front Spring and Shock Absorber Installation—E-150—E-250—E-350 With Spindle Pins

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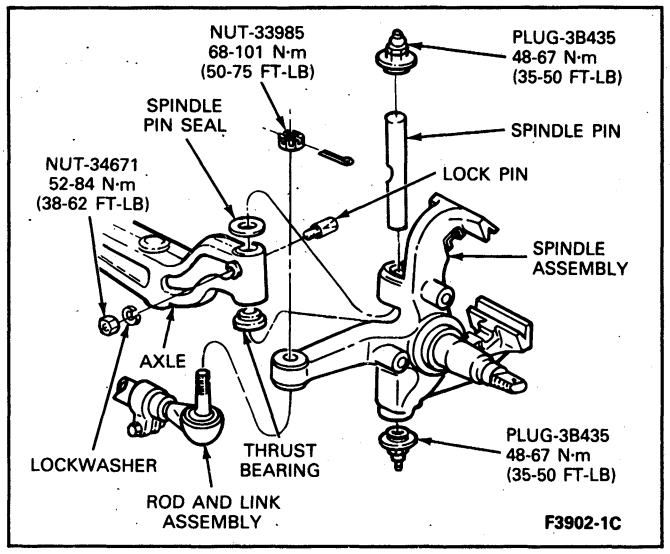


FIG. 8 Front Wheel Spindle Installation—E-150 with Spindle Pins

2. Position the lower end of the shock absorber in the spring spacer eyes. Install the nut and bolt and tighten to specification.

Front Wheel Spindle

E-150—E-250—E-350 and F-Super Duty Series Vehicles

Removal

Refer to Figs. 8, 9, 10 and 11.

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the caliper assembly from the rotor and hold it out of the way with wire. Refer to Caliper Removal instructions in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
4. Remove the dust cap, cotter pin, nut retainer, nut, washer, and outer bearing, and remove the rotor from the spindle.
5. Remove inner bearing cone and seal. Discard the seal.
6. Remove brake dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
7. Disconnect the steering linkage from the spindle arm by removing the cotter pin and nut, and then removing the tie rod end from the spindle arm with TOOL-3290-D or equivalent.
8. On Commercial Stripped Chassis and Motor Home Chassis Vehicles disconnect the drag link from the steering arm with TOOL-3290-D or equivalent.
9. Remove the nut and lockwasher from the lock pin, and remove the lock pin.
10. Remove the upper and lower spindle pin plugs; then, drive the spindle pin out from the top of the axle and remove the spindle and thrust bearing (Figs. 8, 9, 10, 11 and 12). Remove the spindle pin seal and thrust bearing.

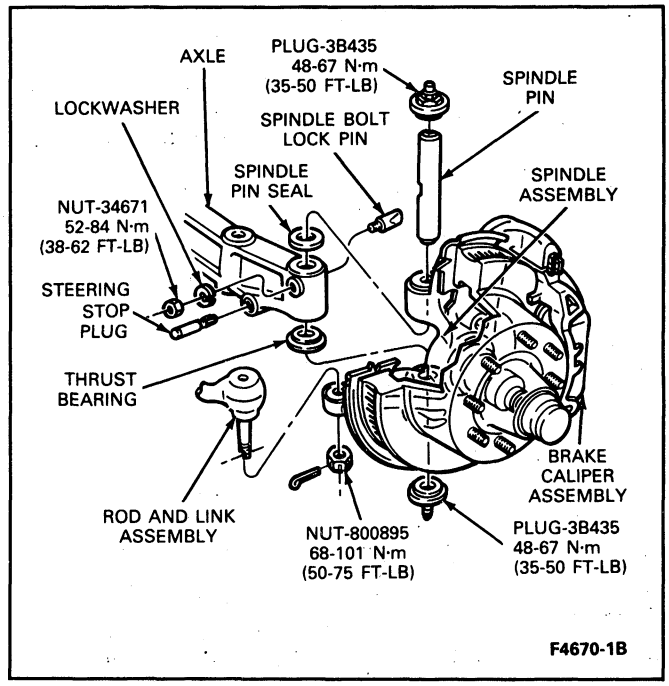


FIG. 9 Front Wheel Spindle Installation—E-250—E-350 with Spindle Pins

Installation

1. Make sure the spindle pin hole in the axle is free of nicks, burrs, corrosion or foreign material. Clean up the bore as necessary and lightly coat the surface with a lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
2. Install a new spindle pin seal with the metal backing facing up towards the bushing into the spindle as shown in Figs. 8, 9, 10, 11 and 12. Gently press seal into position, being careful not to distort the casing.
3. Install a new thrust bearing with the lip flange facing down towards the lower bushing as shown. Press until the bearing is firmly seated against the surface of the spindle.
4. Lightly coat the bushing surfaces with grease and place the spindle in position on the axle.
5. Hold the spindle with thrust bearing in place tight against the axle and measure the space between the axle and the spindle at the top of the axle. Select the proper shims (3117) and install.
6. Install the spindle pin with the "T" stamped on one end towards the top, and the notch in the pin aligned with the lock pin hole in the axle. Insert the spindle pin through the bushings and axle from the top until the spindle pin notch and axle lock pin hole are in line.
7. Install the lock pin with the threads pointing forward and the wedge groove facing the spindle pin notch. Firmly drive the lock pin into position and mount the lockwasher and nut. Tighten the nut to specifications.
8. Install the spindle pin plugs into the threads at the top and bottom of the spindle. Tighten the plugs to 48-67 N·m (35-50 ft-lbs).
9. Lubricate the spindle pin and bushings with C1AZ-19590-BA (ESA-M1C75-B) Long-Life Lubricant, or

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equivalent, through both fittings until grease is visible seeping past the upper seal at the top and from the thrust bearing slip joint at the bottom. If grease does not appear, recheck the installation procedure to correct the problem. Lack of adequate lubrication will result in rapid failure of the spindle components.

10. Install the dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
11. Pack the inner and outer bearing cone with bearing grease. Use a bearing packer. If a bearing packer is unavailable, pack the bearing cone by hand working the grease through the cage behind the rollers.
12. Install the inner bearing cone and seal as described in Section 11-10, Wheel Hubs and Bearings—Front (except Front Drive). Install the hub and rotor on the spindle.
13. Install the outer bearing cone, washer, and nut. Adjust bearing end play and install the nut retainer, cotter pin and dust cap as described in Section 11-10.
14. Install the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
15. Connect the steering tierod and drag link (if equipped) to the spindle. Tighten the nut to specifications and advance the nut as required for installation of the cotter pin.
16. Install the wheel and tire assembly.
17. Lower the vehicle.
18. Check and, if necessary adjust the toe setting. Refer to Section 14-01, General Suspension Service under Adjustments. Check the brakes for proper operation.

Front Wheel Spindle—F-150—F-350 (4x2) with Ball Joints

Removal

Refer to Fig. 11.

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the caliper assembly from the rotor and hold it out of the way with wire. Refer to Caliper Removal instructions in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
4. Remove the dust cap, cotter pin, nut retainer, nut, washer, and outer bearing, and remove the rotor from the spindle.
5. Remove inner bearing cone and seal. Discard the seal.
6. Remove brake dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
7. Disconnect the steering linkage from the integral spindle and spindle arm by removing the cotter pin and nut and then removing the tie rod end from the spindle arm with TOOL-3290-D or equivalent.
8. Remove the cotter pin and castellated nut from the lower ball joint stud.
9. Remove the nut from the axle clamp bolt and remove the bolt from the axle.
10. Remove the camber adjuster from the upper ball joint stud and axle beam.

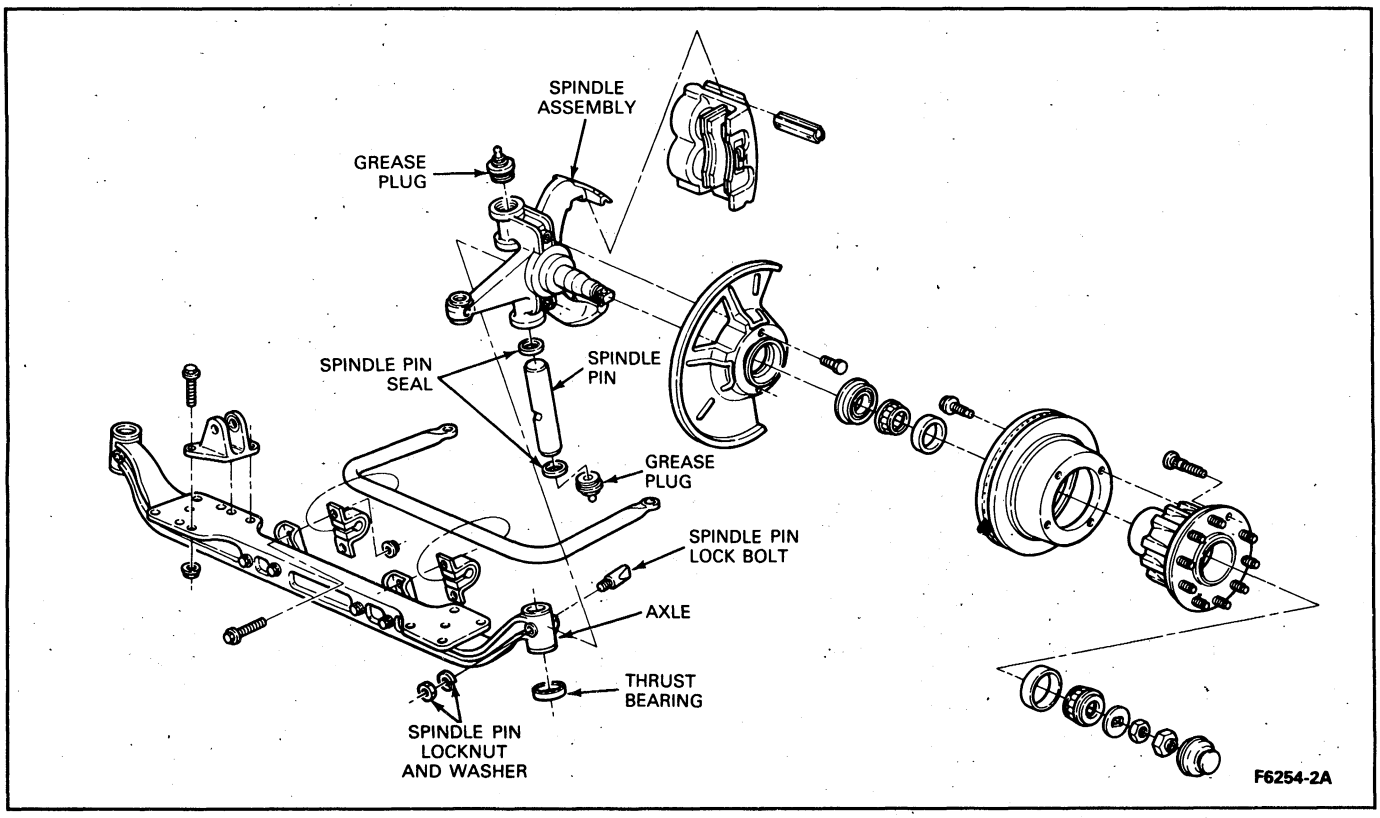


FIG. 10 Front Wheel Spindle Installation—F-Super Duty with Spindle Pins

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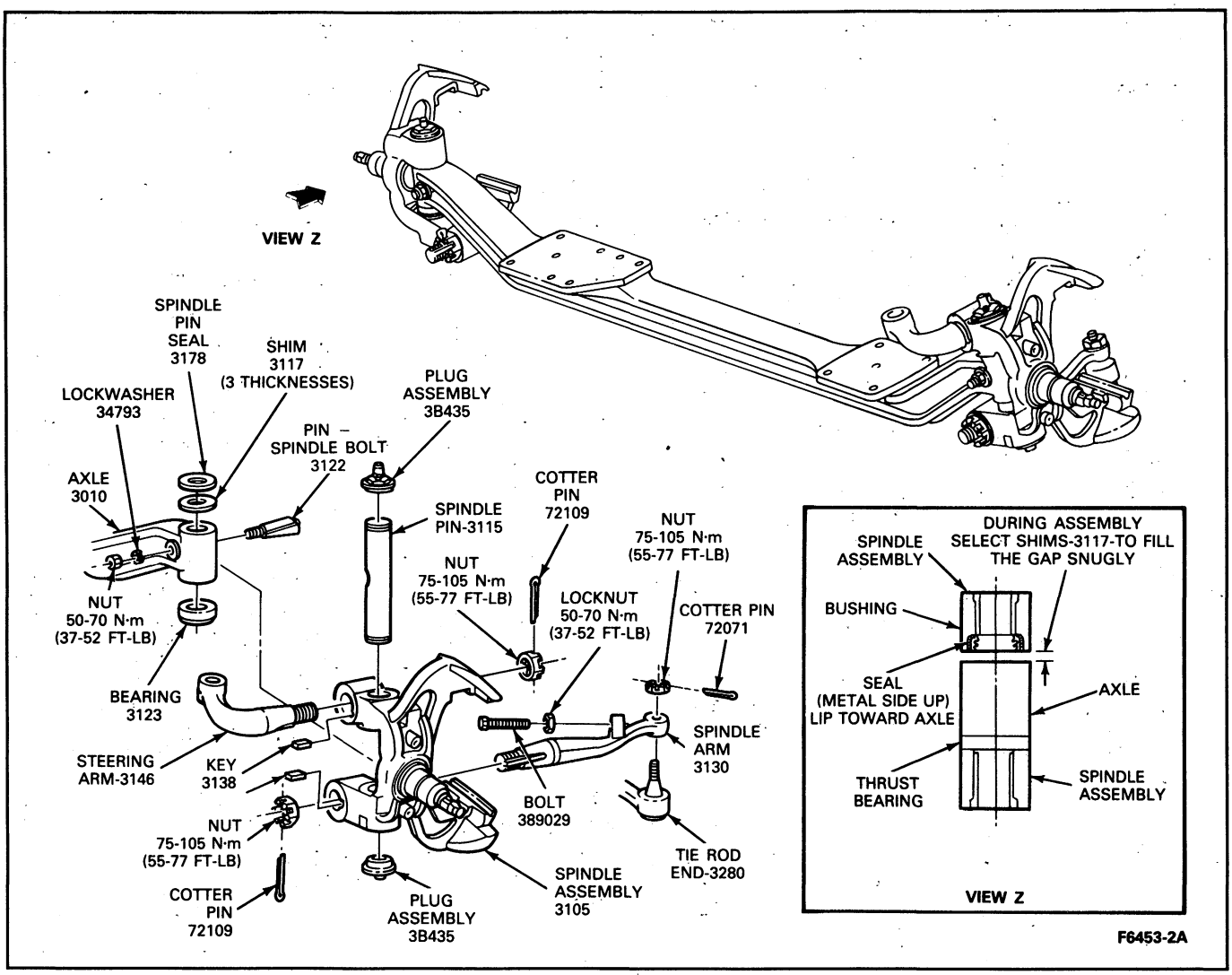


FIG. 11 Front Wheel Spindle Installation—F-Super Duty Commercial Stripped Chassis and Motor Home Chassis

11. Strike the inside area of the axle as shown in Fig. 14 to pop the lower ball joints loose from the axle beam.

    CAUTION: Do not use a pickle fork to separate the ball joint from the axle as this will damage the seal and the ball joint socket.

12. Remove the spindle and ball joint assembly from the axle.

Installation

1. Prior to assembly, make sure the upper and lower ball joint seals are in place in the spindle.
2. Place the spindle and the ball joints into the axle.
3. Install the nut on the lower ball joint stud and partially tighten to 47 N·m (35 ft-lbs).
4. Install the camber adjuster in the upper spindle over the upper ball joint stud. Be sure the adjuster is aligned properly. If camber adjustment is necessary, special adjusters must be installed. Refer to Adjustments in this Section.
5. Tap the adjuster lightly into the spindle. Tighten the lower ball joint stud nut to 149-190 N·m (110-140 ft-lbs) and continue tightening the castellated nut until it lines up with the hole in the stud. Install the cotter pin.
6. Install the clamp bolt and nut into the axle boss. Tighten the nut to 65-88 N·m (48-65 ft-lb).
7. Install the dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
8. Pack the inner and outer bearing cone with a lithium-base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Use a bearing packer. If a bearing packer is unavailable, pack the bearing cone by hand working the grease through the cage behind the rollers.
9. Install the inner bearing cone and seal as described in Section 11-10, Wheels, Hubs and Bearings—Front (except Front Drive). Install the hub and rotor on the spindle.
10. Install the outer bearing cone, washer, and nut. Adjust bearing end play and install the nut retainer, cotter pin and dust cap as described in Section 11-10 Wheels, Hubs and Bearings—Front (Except Front Drive).
11. Install the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
12. Connect the steering linkage to the spindle. Tighten the nut to 94-135 N·m (70-100 ft-lbs) and

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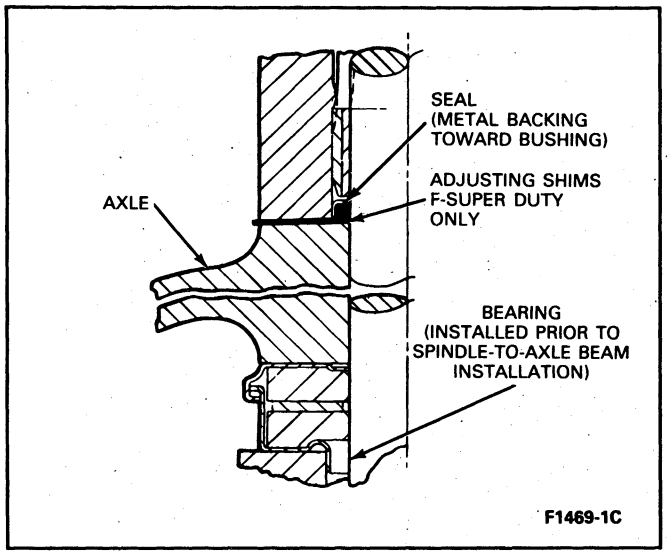


FIG. 12 Bearing Seal Installation, E-150—E-250—E-350 and F-Super Duty—Typical

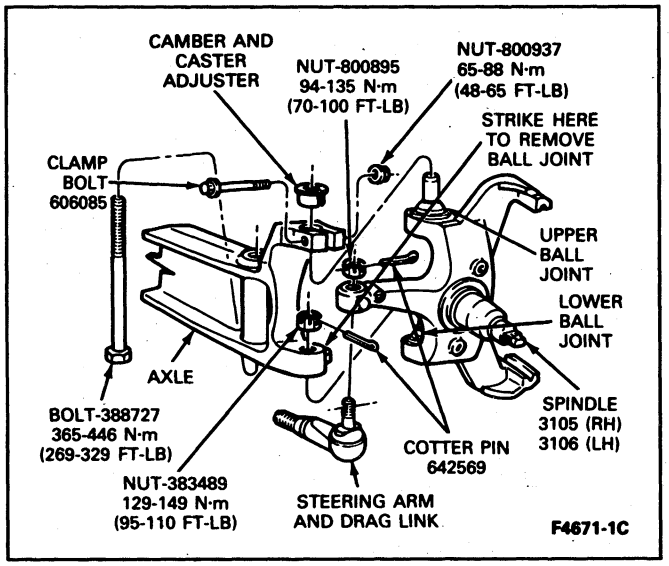


FIG. 13 Front Wheel Spindle Installation—F-150—F-350 (4x2)

advance the nut as required for installation of the cotter pin.

13. Install the wheel and tire assembly.
14. Lower the vehicle.
15. Check and, if necessary adjust the toe setting. Refer to Section 14-01, General Suspension Service under Adjustments. Check the brakes for proper operation.

Camber Adjuster—F-150—F-350 (4x2) with Ball Joints

Removal

1. Remove the upper ball joint camber adjuster clamp bolt nut and remove the clamp bolt from the axle.
2. Remove the camber adjuster from the axle using Tool D81T-3010-B to wedge the adjuster out of the axle.

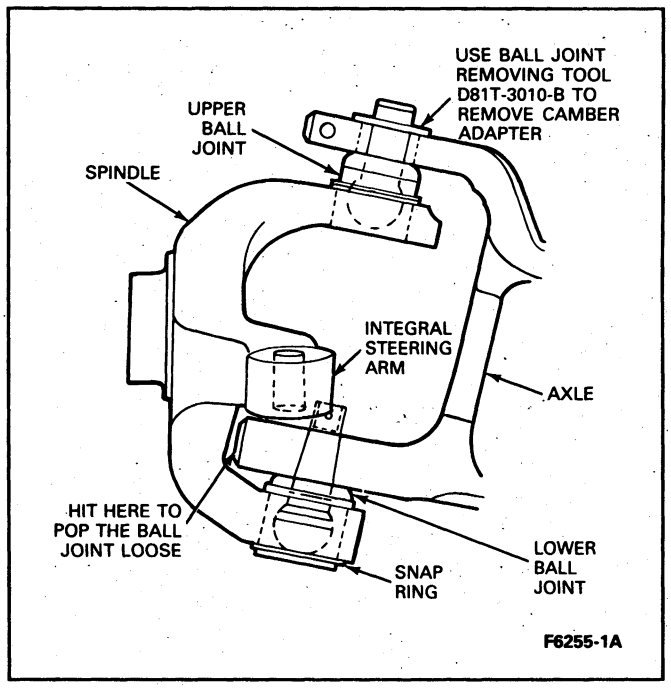


FIG. 14 Spindle Removal

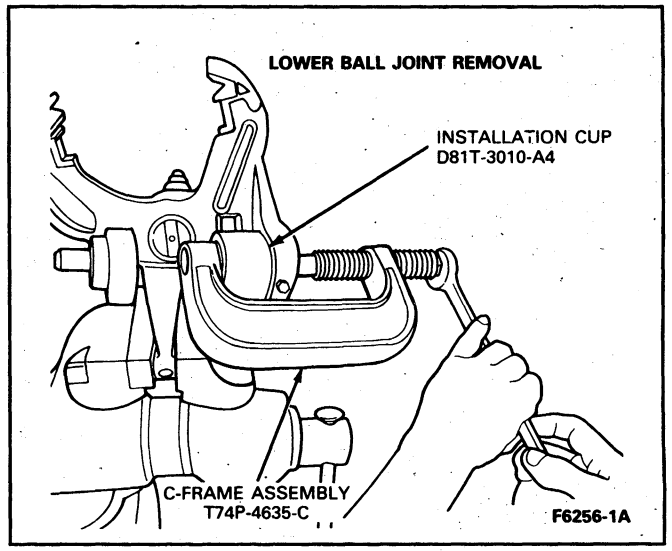


FIG. 15 Lower Ball Joint Removal

Installation

1. Install the correct camber adjuster into the axle aligning the slot in the adjuster correctly.
2. Install the adjuster on the upper ball joint stud and tap the adjuster into the axle.
3. Install the clamp bolt and nut in the axle. Tighten the nut to 65-88 N·m (48-65 ft-lb).

Upper and Lower Ball Joints—F-150—F-350 (4x2) with Ball Joints

Removal

1. Remove the spindle and ball joint assembly from the axle as described in this section under Front Wheel Spindle-F-150—F-350 (4x2) with ball joints.
2. Install the spindle assembly in a vise and remove the snap ring from the lower ball joint. Remove the

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lower ball joint from the spindle using tool T74P-4635-C C-frame, and receiver cup D81T-3010-A4. Turn the forcing screw clockwise until the ball joint is removed from the spindle.

3. Assemble C-Frame assembly and receiver cup on the upper ball joint and turn forcing screw clockwise until ball joint is removed from the spindle.

   NOTE: Always remove lower ball joint first.

CAUTION: Do not heat the ball joint or the spindle to aid in removal.

Installation

NOTE: Lower ball joint must be installed into the spindle first.

1. To install the lower ball joint, assemble C-Frame assembly, Ball Joint Receiver Cup (D81T-3010-A5) and Installation Cup (D81T-3010-A1 and D81T-3010-A3) inside cup (D81T-3010-A4) in position on the spindle. Turn forcing screw clockwise until ball joint is seated.

   CAUTION: Do not heat the ball joint or axle to aid in installation.

2. Install the snap ring onto the ball joint.
3. To install the upper ball joint, assemble the C-frame in position on the spindle and repeat Step 1.
4. Install the spindle and ball joint assembly as described in this Section.

Axle Pivot Bushing

Removal

Refer to Fig. 19.

1. Remove front coil spring as described in this Section under Front Spring Removal and Installation.
2. Remove the axle pivot nut and bolt. Pull the pivot end of axle down until bushing is exposed.
3. Install Forcing Screw (T78P-5638-A1), Bushing Remover T80T-5638-A2 and Receiver Cup (T78P-5638-A4) or their equivalents onto pivot bushing. Turn the forcing screw clockwise to remove the pivot bushing.

Installation

Refer to Fig. 20 and 21.

1. Place pivot bushing in axle. Assemble Receiver Cup (T78P-5638-A2), Forcing Screw (T78P-5638-A1) and Bushing Replacer (T78P-5638-A3) or equivalents, as shown in Fig. 20. Add four to six washers between head of forcing screw and Bushing Replacer (T78P-5683-A3). Install bushing into axle, leaving 0.210-0.290 inch gap between the shoulder of the bushing outer metal and the face of the I-Beam as shown in Figure 21.
2. Position axle in pivot bracket and install axle pivot bolt through the bracket and axle. Install nut but do not tighten at this time.
3. Install spring, following the procedure in this Section. Make sure spring is seated.
4. Lower vehicle and with the weight on the suspension, tighten pivot bushing bolt and nut to 163-203 N·m (120-150 ft-lbs).

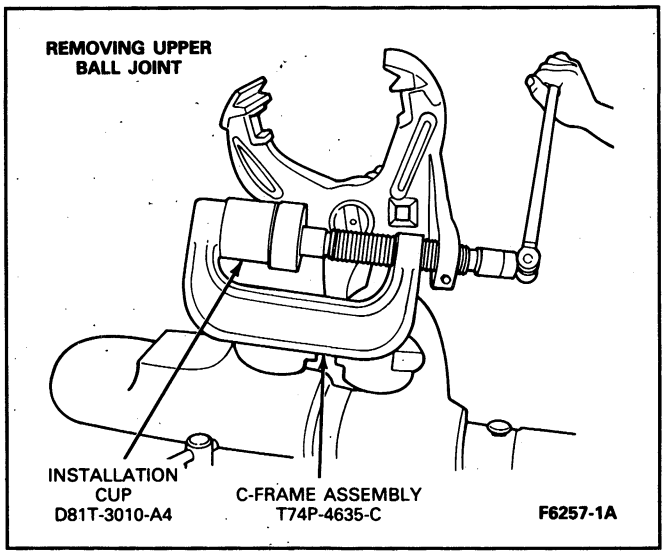


FIG. 16 Upper Ball Joint Removal

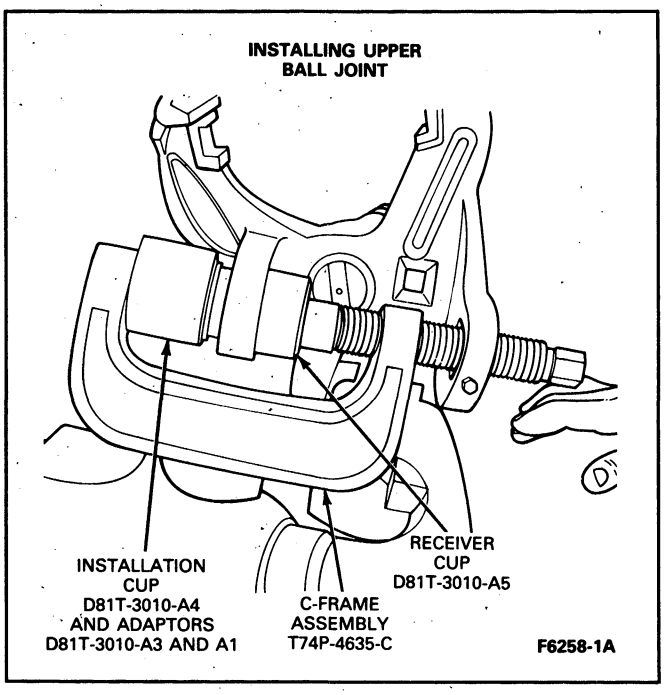


FIG. 17 Upper Ball Joint Installation

Radius Arm

Refer to Figs. 22 and 23.

Removal

1. Raise the front of the vehicle, and place safety stands under the frame. Place a jack under the axle.
2. Remove front tires.
3. Disconnect front stabilizer bar (if so equipped) at the link.

   NOTE: The axle must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the disc brake caliper must be removed from the spindle according to the

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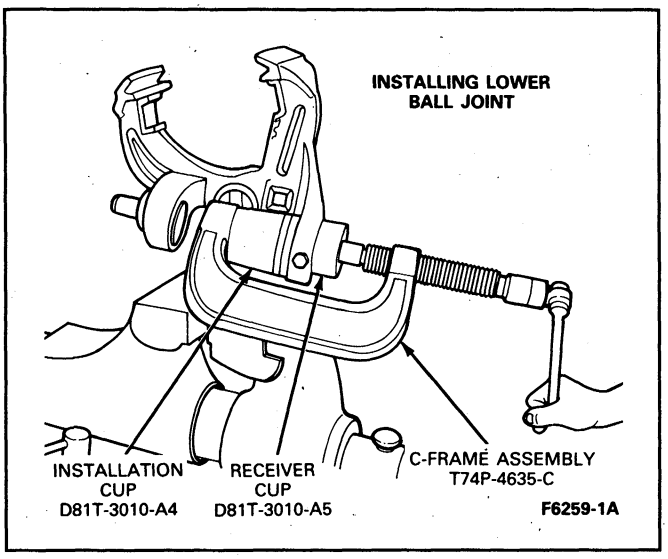


FIG. 18 Lower Ball Joint Installation

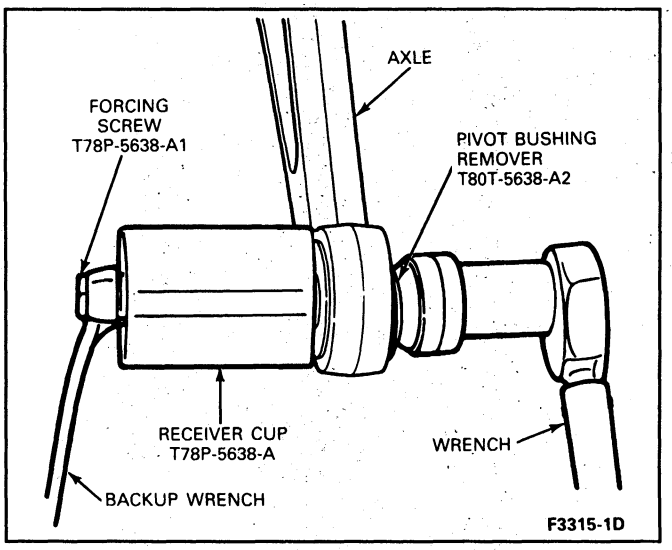


FIG. 19 Removing Axle Pivot Bushing

procedures specified in Section 12-24 Disc Brakes—Light and Heavy Duty-Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the brake hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.

4. Disconnect the lower end of the shock absorber from the shock lower bracket (bolt and nut).
5. Remove the front spring as outlined in this Section.
6. Remove the spring lower insulator and seat from the radius arm, and then remove the bolt and nut that attaches the radius arm to the axle.
7. Remove the nut, rear washer, insulator and spacer (F-150—F-250—F-350) from the rear side of the radius arm rear bracket.
8. Remove the radius arm from the vehicle, and remove the spacer (E-150—E-250—E-350) inner insulator and retainer from the radius arm stud.

Installation

1. Position the front end of the radius arm to the axle. Install the attaching bolt from underneath through the radius arm and axle, and then install the nut finger-tight.
2. Install the retainer, inner insulator and spacer (E-150—E-250—E-350) on the radius arm stud and insert the stud through the radius arm rear bracket.
3. Install the spacer (F-150—F-250—F-350), insulator, rear washer and nut on the arm stud at the rear side of the arm rear bracket. Tighten the nut to 109-162 N·m (80-120 ft-lbs).
4. Tighten the nut on the radius arm to the axle bolt using the following torque: F-150—F-250—F-350, 365-446 N·m (269-329 ft-lbs) E-150—E-250—E-350, 326-433 N·m (240-320 ft-lbs).
5. Install the spring lower seat and spring insulator on the radius arm so that the hole in the seat goes over the arm-to-axle bolt.
6. Install the front spring as outlined in the foregoing procedures in this Section.
7. Connect the lower end of the shock absorber to the lower bracket on the radius arm with the attaching bolt and nut. On the F-150—F-250—F-350, the bolt head must be installed towards tire. Tighten the nut to 70-100 N·m (52-74 ft-lbs). On the E-150—E-250—E-350, tighten the nut to 55-81 N·m (40-60 ft-lbs).
8. Reinstall front stabilizer bar (if so equipped) to link. Tighten nut to 70-100 N·m (52-74 ft-lbs).
9. Reinstall front brake calipers if removed.
10. Reinstall front tires.
11. Lower the vehicle.

Radius Arm Rear Bracket—E-150-E-250-E-350

With the radius arm removed from the bracket, remove the three rear bracket-to-frame bolts and remove the bracket. Position the replacement bracket to the frame and install the three attaching bolts and nuts (Fig. 7). **Do not completely tighten one at a time. Partially tighten all three and repeat in sequence until specified torque of 102-142 N·m (75-105 ft-lbs) is obtained for all.**

Jounce Bumper

Refer to Fig. 24

Removal

1. Remove hex head bolt that holds jounce bumper to Frame. Remove jounce bumper.

Installation

1. Place the jounce bumper in position under the frame and spring upper seat. For F-150—F-250—F-350 (4x2) vehicles, position jounce bumper in rearward set of holes on R.H. side of the frame.

   NOTE: The rearward set of holes are for F-150—F-250—F-350 (4x2) vehicles only. The forward set of holes are for F-150 (4x4) and Bronco only.

2. Install bolt and tighten to 19-29 N·m (14-22 ft-lbs) for F-150—F-250—F-350, 25-40 N·m (20-30 ft-lbs) for E-150—E-250—E-350.

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Jounce Bumper

F-Super Duty

Refer to Figs. 6 and 27.

Removal

1. Remove the two nuts from the U-bolt that holds the bumper mounting bracket to the side rail.
2. If required, remove the nut that holds the bumper assembly to the bumper mounting bracket.

Installation

1. If removed, install the bumper assembly to the bumper mounting bracket. Tighten the nuts to 25-40 N·m (18-30 ft-lbs).
2. Position the bumper and mounting bracket assembly on the frame side rail. Install the U-bolt and tighten the retaining nuts to 25-40 N·m (18-30 ft-lbs.).

Axle Pivot Bracket (Right Side)

F-150—F-250—F-350 (4x2)

Refer to Fig. 26

Removal

1. Remove front spring and radius arm as described in this Section and remove the I-Beam Axle and wheel spindle assembly.
2. Remove the four attaching nuts and bolts and remove the axle pivot bracket.

Installation

1. Position the axle pivot bracket to the crossmember. Loosely install the bolts, bolt and retainer nuts. Do not tighten at this time.

   NOTE: The two rearward vertical bolts must be installed with the bolt heads next to the engine oil pan to maintain the required clearance. The bolt and retainer assembly must be installed with the bolt heads on the inside surface of the pivot bracket.
2. To ensure correct positioning of the axle pivot brackets, tighten the two forward (horizontal) fasteners to 149 N·m (110 ft-lbs) first. Then, tighten the two rearward (vertical) bolts and nuts (at top of crossmember) to 149 N·m (110 ft-lbs).
3. Install the I-beam axle and wheel spindle assembly, front spring and radius arm as described in this Section.

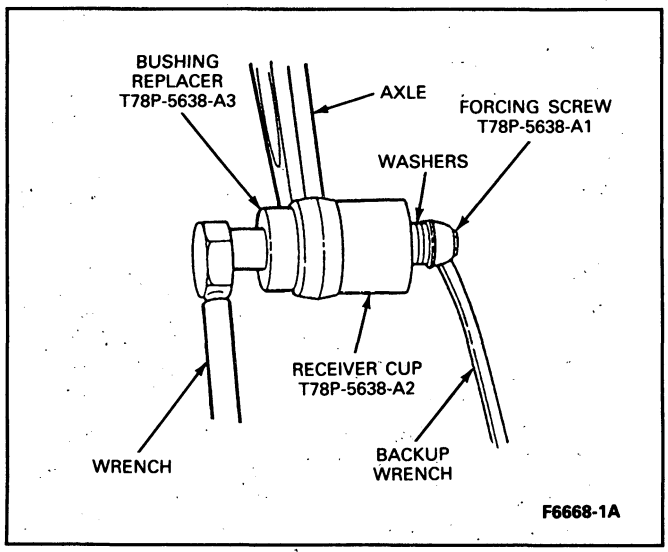


FIG. 20 Installing Axle Pivot Bushing

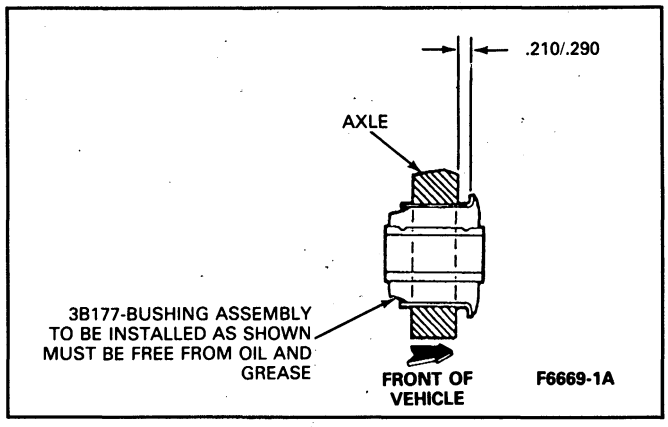


FIG. 21 Axle Pivot Bushing Installed

Front Stabilizer Bar

E-150—E-250—E-350

Removal

1. Disconnect the left and right ends of the front stabilizer bar from the link assembly attached to the I-Beam bracket (Fig. 27).
2. Disconnect the retainer bolts and remove the stabilizer bar.
3. Disconnect the stabilizer link assemblies by loosening the right and left locknuts from their respective I-Beam brackets.

Installation

1. Connect the right and left stabilizer links to their respective I-Beam brackets by sliding the bolt with washer through the link, the I-Beam bracket hole and toward the inside of the side rail. Tighten the washer and locknut to 55-81 N·m (40-60 ft-lbs). **The link must be installed with the bend facing forward on E-150—E-250—E-350 as shown in Fig. 27.**
2. Connect the stabilizer bar to the frame side rails by placing the two retainers on the bottom of the side rails and tightening the four through bolts to 21-33 N·m (15-25 ft-lbs) torque (Fig. 27).
3. Connect the stabilizer bar left and right ends to the left and right link assemblies respectively making sure that the washers and insulators are properly positioned as in Fig. 27. Tighten the retaining nuts to 25-37 N·m (18-28 ft-lbs).

Front Stabilizer Bar

F-150—F-250—F-350 (4x2)

Refer to Fig. 28

Removal

1. Disconnect the left and right ends of the front stabilizer bar from the link assembly attached to the spring seat (Fig. 28).
2. Disconnect the retainer bolts and remove the stabilizer bar.

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3. Disconnect the stabilizer link assemblies by loosening the right and left locknuts from their respective I-Beam brackets.

Installation

1. Loosely assemble the entire stabilizer bar system with both link assemblies outboard of the stabilizer bar. Force the stabilizer bar rearward to connect the bar ends to the link assemblies.

2. Tighten the nuts and bolts retaining the link assemblies to the stabilizer bar and spring seat to 71-100 N·m (53-74 ft-lbs).

3. Check to be sure the insulators are seated in the retainers and that the stabilizer bar is centered in the assembly.

   Tighten the stabilizer bar-to-frame retainer nuts and bolts to 37-50 N·m (27-37 ft-lbs).

Front Stabilizer Bar

F-Super Duty Chassis Cab

Refer to Fig. 29

Removal

1. Disconnect the left and right ends of the front stabilizer bar from the link assembly attached to the frame side rail mounting brackets.
2. Disconnect the retainer bolt and remove the stabilizer bar from the front axle.
3. Disconnect the stabilizer link assemblies by removing them from the frame side rail mounting brackets.

Installation

1. Loosely assemble the entire stabilizer bar system with both link assemblies loosely attached to the frame mounting brackets, and the stabilizer bar in position on the axle.
2. Check to be sure the stabilizer bar insulators are seated in the retainers and that the stabilizer bar is centered on the axle. Attach the stabilizer bar to the axle by assembling the retainers to the axle

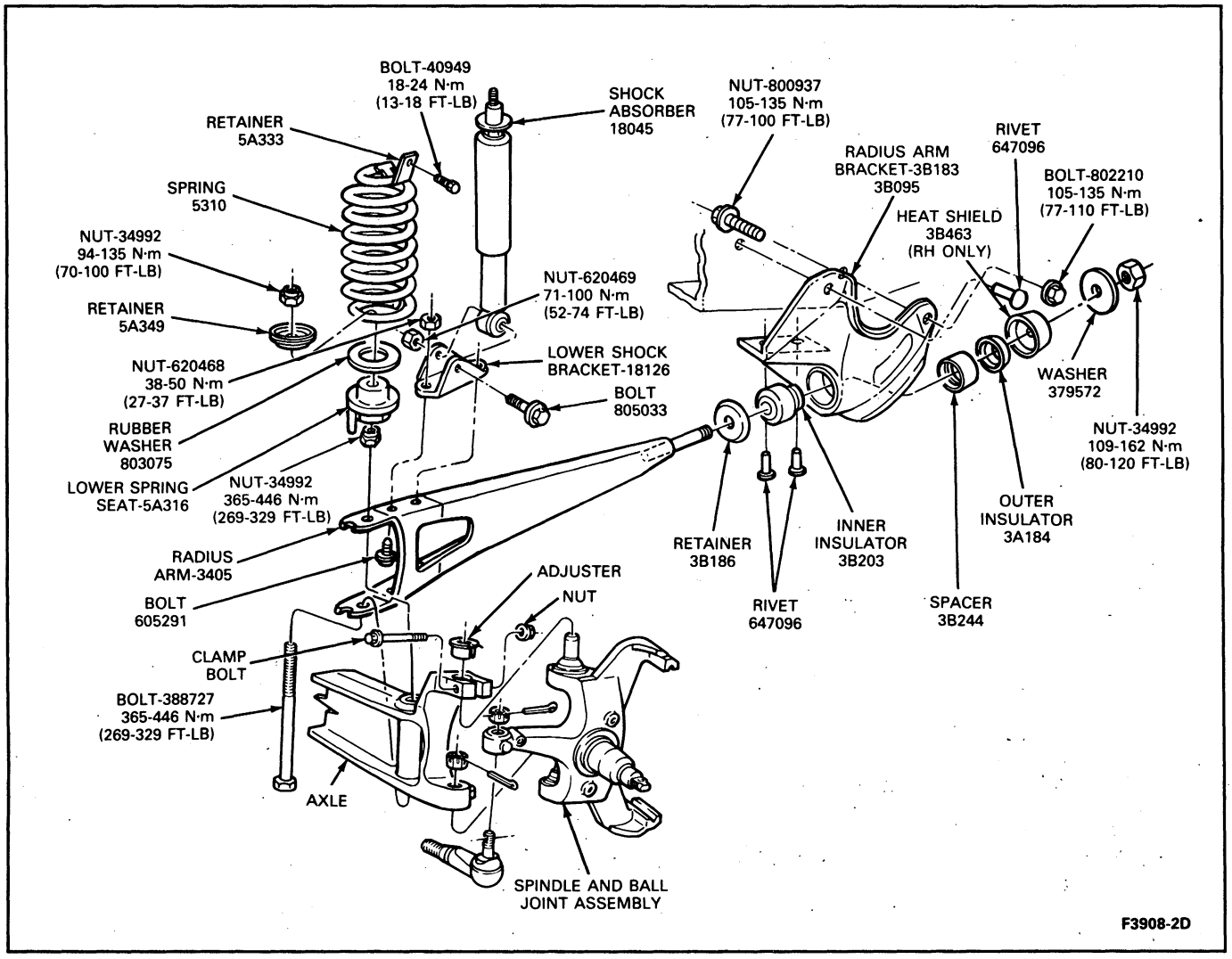


FIG. 22 Radius Arm Installation—F-150—F-250—F-350 (4x2)—F-250—F-350 Shown

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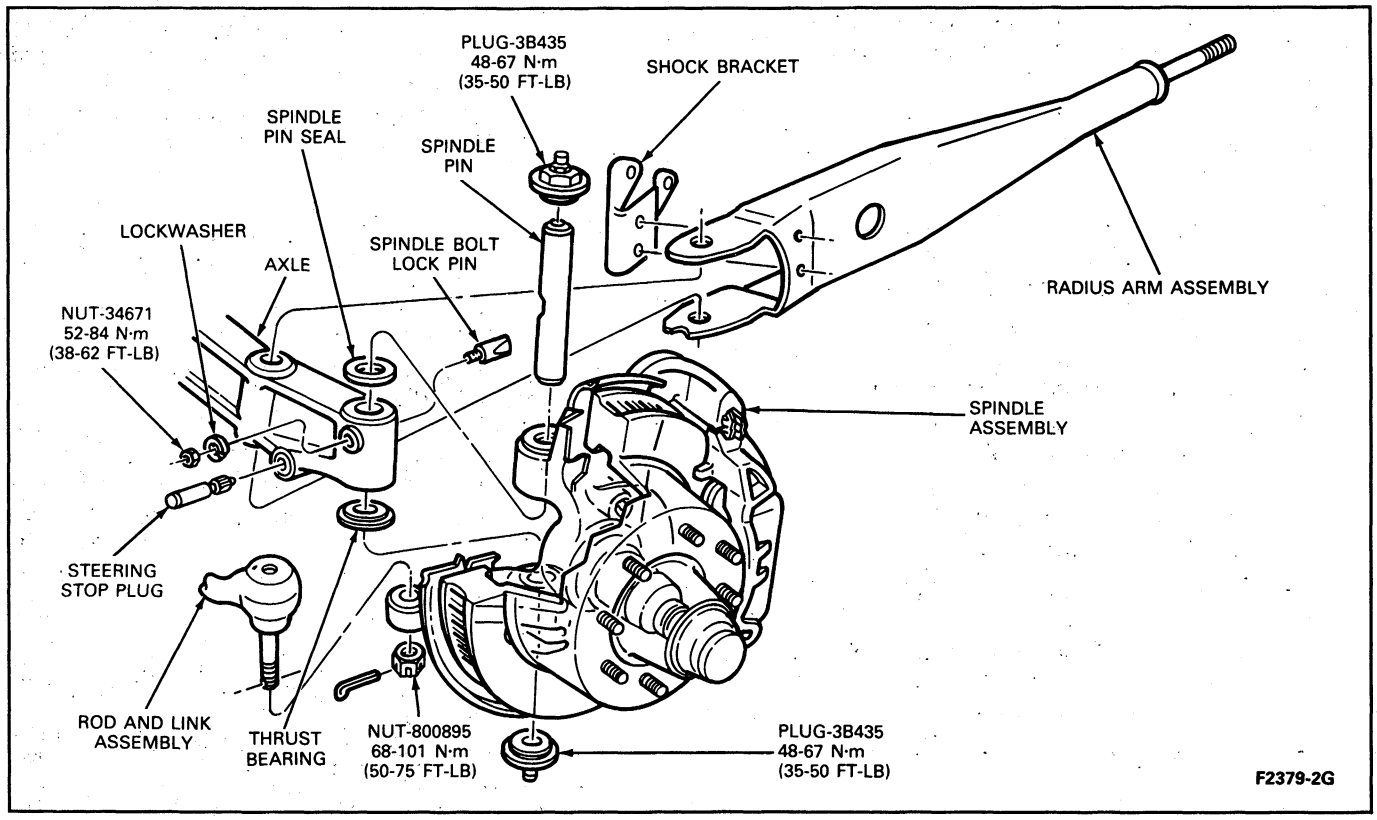


FIG. 23 Radius Arm Assembly—E-250 and E-350

mounting brackets. Tighten the retainer screws to 48-68 N·m (35-50 ft-lb).

3. Install the link assemblies to the frame mounting brackets using the bolts, washers and locknuts. Tighten the locknut to 70-100 N·m (52-74 ft-lb).
4. Install the link assembly to the stabilizer bar with 2 cup washers, 2 rubber insulators and 1 locknut. Tighten the locknut to 21-32 N·m (15-25 ft-lb).

Front Stabilizer Bar

F-Super Duty Commercial Stripped Chassis and Motor Home Chassis Vehicles

Removal

Refer to Fig. 30.

1. Disconnect the left and right ends of the front stabilizer bar from the link assembly attached tot he front axle.
2. Remove the nuts and bolts connecting the stabilizer bar to the frame. Remove the stabilizer bar.
3. Disconnect the stabilizer bar link assemblies by removing them from the axle mounting brackets.

Installation

1. Loosely assemble the entire stabilizer bar system with both link assemblies loosely attached to the axle mounting brackets, and the stabilizer bar in position on the frame.
2. Check to be sure that the stabilizer bar insulators are seated in the retainers and that the stabilizer bar is centered on the frame. Attach the stabilizer bar to the frame by assembling the retainers to the frame mounts. Tighten the bolts to 40-64 N·m (30-47 fl-lb).
3. Install the link assemblies to the axle mounting brackets using the bolts, washers and locknuts. Tighten to 77-110 N·m (57-81 ft-lb).
4. Install the link assemblies to the stabilizer bar with 2 cup washers, 2 rubber insulators and 1 locknut. Tighten the locknut to 20-34 N·m (15-25 ft-lb).

Track Bar

F-Super Duty Chassis Cab

Removal

1. Remove the bolt and nut attaching the track bar assembly to the mounting bracket attached to the number 1 crossmember (Fig. 31).
2. Remove the bolt and nut attaching the track bar to the mounting bracket at the axle.
3. Remove the track bar.

Installation

1. Attach the track bar to the number 1 crossmember mounting bracket with a bolt and locknut. Tighten the nut to 163-203 N·m (120-150 ft-lb).
2. Attach the track bar to the axle mounting bracket with the bolt and nut. Tighten the nut to 163-203 N·m (120-150 ft-lb).

Front Twin-I-Beam Axle

Refer to Figs. 26 and 32.

Removal

1. Remove the front wheel spindle, the front spring, and the stabilizer bar (if so equipped) as outlined in the foregoing procedures.

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2. Remove the spring lower seat from the radius arm, and then remove the bolt and nut that attaches the radius arm to the (I-Beam) front axle.
3. Remove the axle-to-frame pivot bracket bolt and nut.

Installation

1. To install, position the axle to the frame pivot bracket and install the bolt and nut finger-tight.
2. Position the opposite end of the axle to the radius arm. Install the attaching bolt from underneath through the bracket, the radius arm, and the axle.
3. Install the spring lower seat and spring insulator on the radius arm so that the hole in the seat indexes over the arm-to-axle bolt and the pin on the spring seat engages the slot in the radius arm.
4. Install the front spring as outlined in this Section.
5. Install the front wheel spindle and, if so equipped, the stabilizer bar as outlined in this Section.
6. Lower the vehicle. With the weight on the suspension, tighten the axle-to-frame pivot bolt to 163-203 N·m (120-150 ft-lbs).

Front Axle

F-Super Duty Series Vehicles

Refer to Figs. 5 and 6.

Removal

1. Using a hoist, raise the vehicle by the frame until the weight is off the front springs with the wheels still touching the floor.
2. Remove the wheel and tire assemblies.
3. Remove the caliper assemblies from the rotators and hold them out of the way with wire. Refer to caliper removal instructions in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
4. Install the wheel and tire assemblies with 3 or 4 lug nuts finger tight.
5. Remove the nuts that hold the stabilizer links to the stabilizer bar. Remove the washers and insulators and disconnect the links from the bar.
6. Disconnect the steering drag link from the steering arm on the spindle using TOOL-3290-D or equivalent. Wire the steering drag link to the frame.
7. On Chassis Cab vehicles, remove the nut and bolt securing the tracking bar to the axle and disconnect the bar from the axle mounting bracket.
8. Remove the nuts from the U-bolts that hold the springs to the axle. Remove the U-bolts and stabilizer bar brackets, or jack brackets.
9. Raise the vehicle and roll the axle out from under the vehicle.

Installation

1. Position the axle so the spring seats on the I-beam link up with the locating boss on the spring.
2. Install the U-bolts and the jack brackets or stabilizer bar brackets. Tighten the U-bolt nuts to specifications.
3. Connect the steering drag link to the steering arm on the spindle. Install the castellated nuts and tighten to specifications.
4. On Chassis Cab vehicles, position the tracking bar to the axle, install the nut and bolt. Tighten to 163-203 N·m (120-150 ft-lb).
5. Position the ends of the stabilizer links onto the stabilizer bar. Install the insulators, washers and nuts and tighten to 20-34 N·m (15-25 ft-lb).
6. Install the calipers as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
7. Lower the vehicle.

Spindle Bushing—Bronze

Refer to Fig. 33

Removal and Installation

1. Remove the spindle as described in this Section. Install the spindle in a vise.
2. On E-150 vehicles (bronze spindle bushings have an inside diameter of 0.8600/0.8610 inch) use the following tools: Reamer, T53T-3110-DA Bushing Remover/Installer Driver, D82T-3110-G and Driver Handle, D82T-3110-C. (Fig. 34)

   On E-250—E-350 vehicles (bronze spindle bushings have an inside diameter of 1.0552/1.0562 inch) use the following tools: Reamer, D82T-3110-A, Bushing Remover/Installer Driver, D82T-3110-B and Driver Handle, D82T-3110-C (Fig. 34).

   On the F-Super Duty, the bronze spindle bushings have an inside diameter of 1.301/1.302 inch and use the following tools: Reamer, D88T-3110-BH, Bushing Remover/Installer Driver, D88T-3110-AH and Driver Handle, T80T-4000-W.

   Each side of the Bushing Remover/Installer Driver tool is marked with a 'T' or a 'B'. Use the side with the 'T' stamping to install the top spindle bushing. Use the side with the 'B' stamping to install the bottom spindle bushing.
3. Remove and discard the seal from the bottom of the upper bushing bore of the upper spindle yoke.
4. Remove and install the top spindle bushing first. Install the driver handle through the bottom bore. Position a new bushing on the 'T' side stamping of the bushing Remover/Installer Driver. The bushing must be installed on the tool so the open end grooves will face outward when installed. Position the new bushing and driver over the old bushing, insert the handle into the driver and drive the old bushing out while the new bushing is driven in (Fig. 35). Drive until the tool is seated. The bushing will then be seated at the proper depth (0.080 inch minimum from bottom of upper spindle boss).

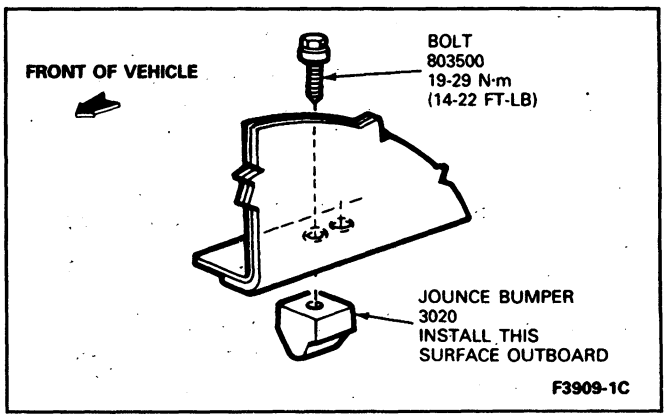


FIG. 24 Jounce Bumper Installation—F-150—F-250—F-350

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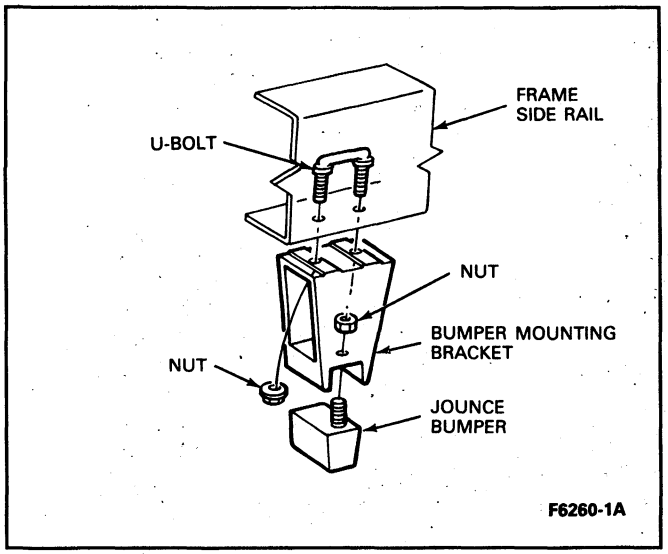


FIG. 25 Front Axle Jounce Bumper—F-Super Duty

5. Remove and install the bottom spindle bushing. Install the Driver Handle through the top bushing bore. Position a new bushing on the 'B' side stamping of the Bushing Remover/Installer Driver. The bushing must be installed on the tool so the open-end grooves will face outward when installed. Position the new bushing and driver over the old bushing in the bottom spindle bore. Insert the handle into the driver and drive the old bushing out while the new bushing is driven in (Fig. 36). Drive until the tool is seated. The bottom bushing will then be seated at the proper depth (0.130 inch minimum from the top of the lower spindle boss).
6. Ream the new bushings to 0.025-0.076mm (0.001-0.003 inch) larger than the diameter of a new spindle pin. Ream the top bushing first with the reamer tool. Install the smaller diameter of the tool through the top bore and into the bottom bore until the reaming threads are in position in the top bushing. Turn the tool until the threads exit the top bushing. Ream the bottom bushing (Fig. 37). The larger diameter portion of the tool will act as a pilot in the top bushing to properly ream the bottom bushing.
7. Clean all the metal shavings from the bronze bushings after reaming. Coat the bushings and spindle pin with Long Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
8. Install a new seal on Bushing Remover/Installer Driver tool on the side with the 'T' stamping. Install the handle into the driver and push the seal into position in the bottom of the top bushing bore.

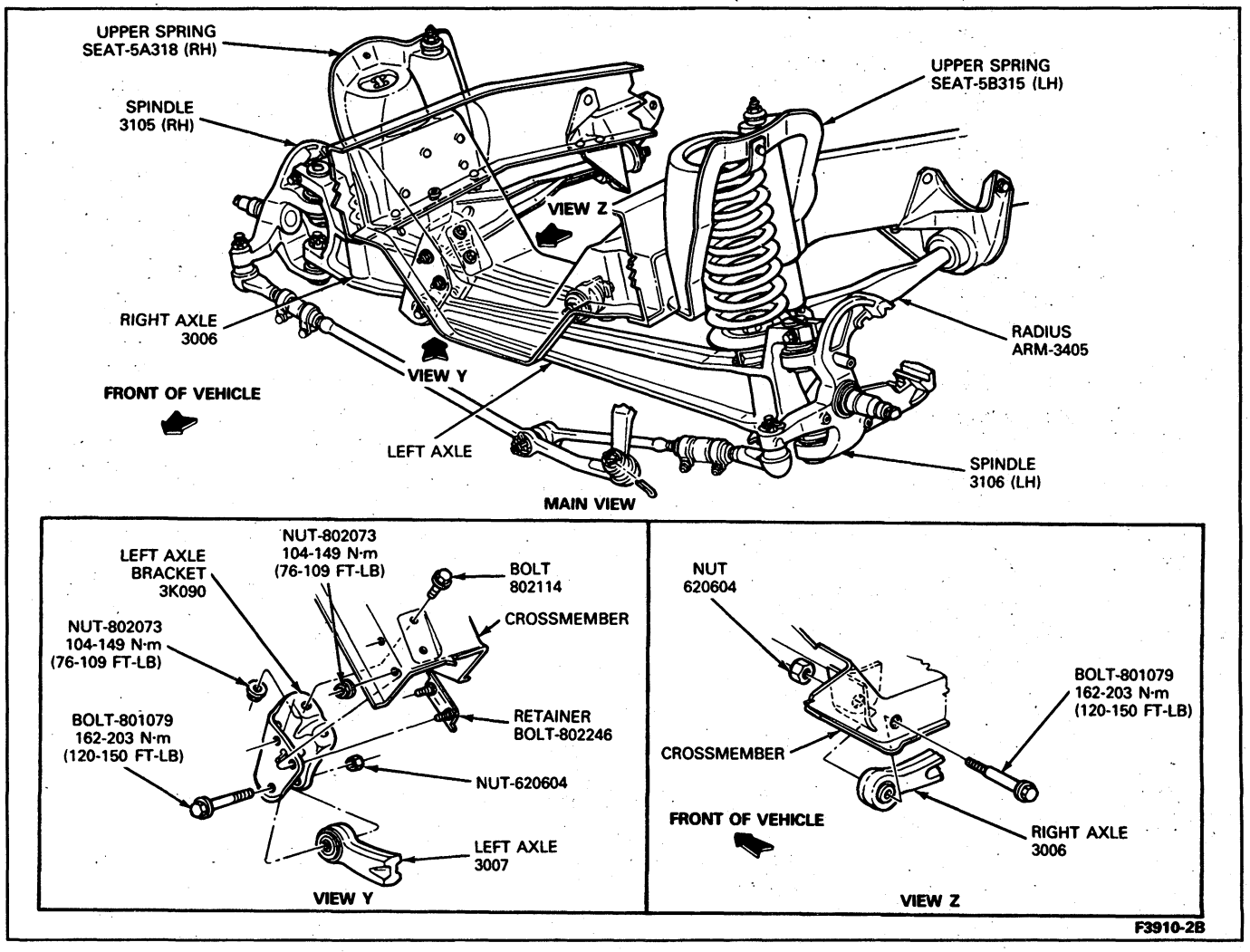


FIG. 26 Axle Pivot Bracket and Axle Arm Installation—F-150—F-250—F-350—F-150 Shown

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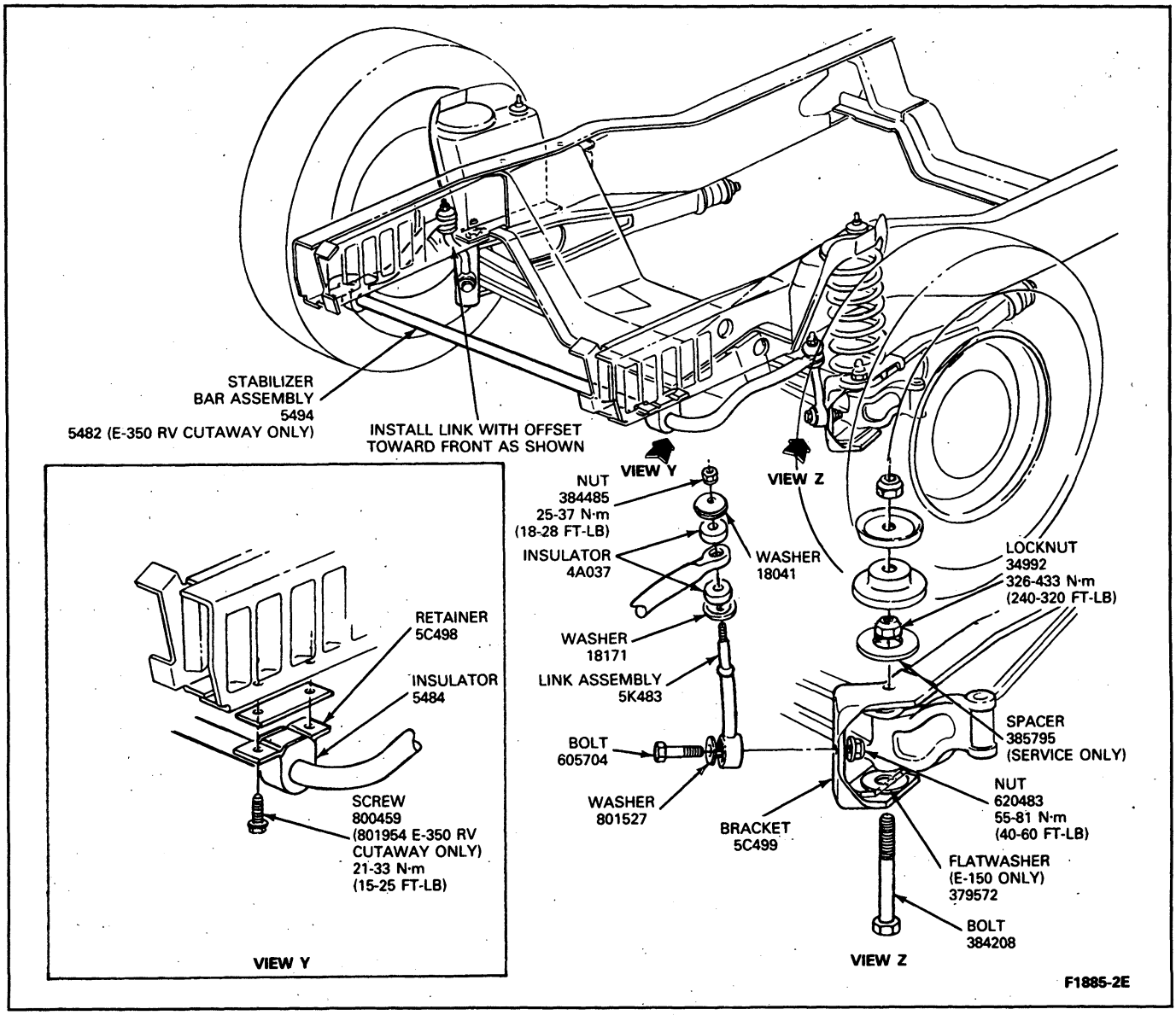


FIG. 27 Front Stabilizer Bar Installation—E-150—E-250—E-350

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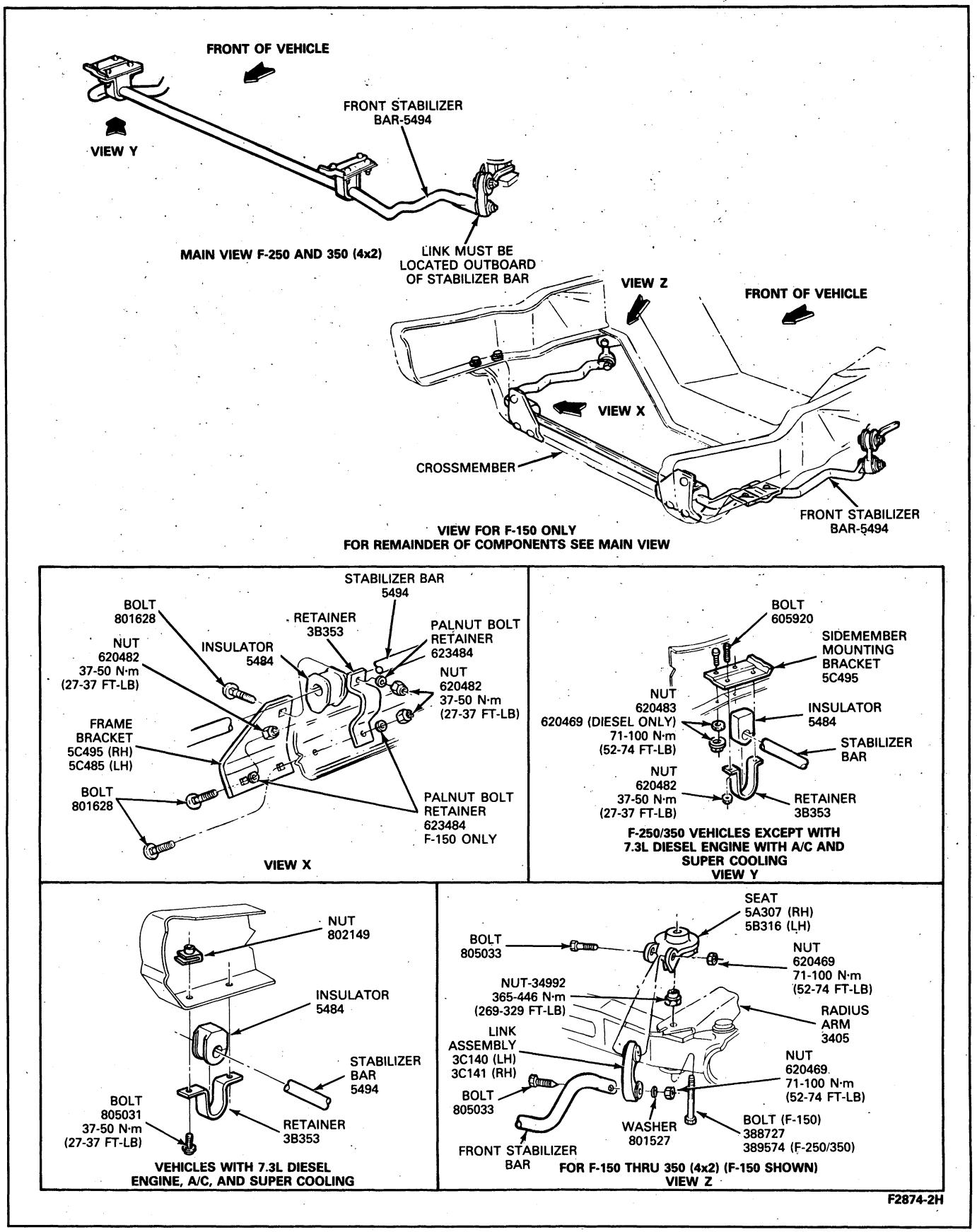


FIG. 28 Front Stabilizer Bar Installation—F-150—F-250—F-350 (4x2)

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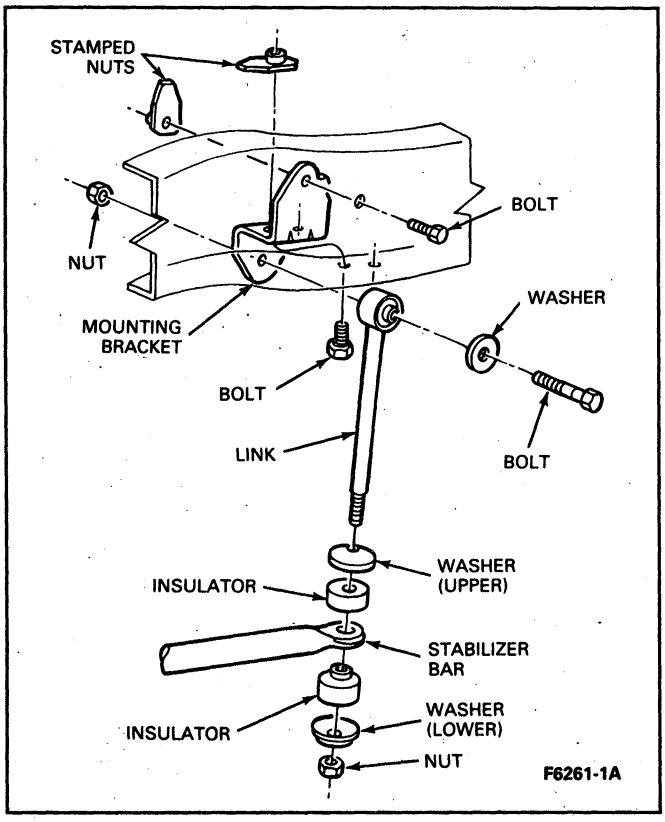


FIG. 29 Front Stabilizer Bar Installation—F-Super Duty

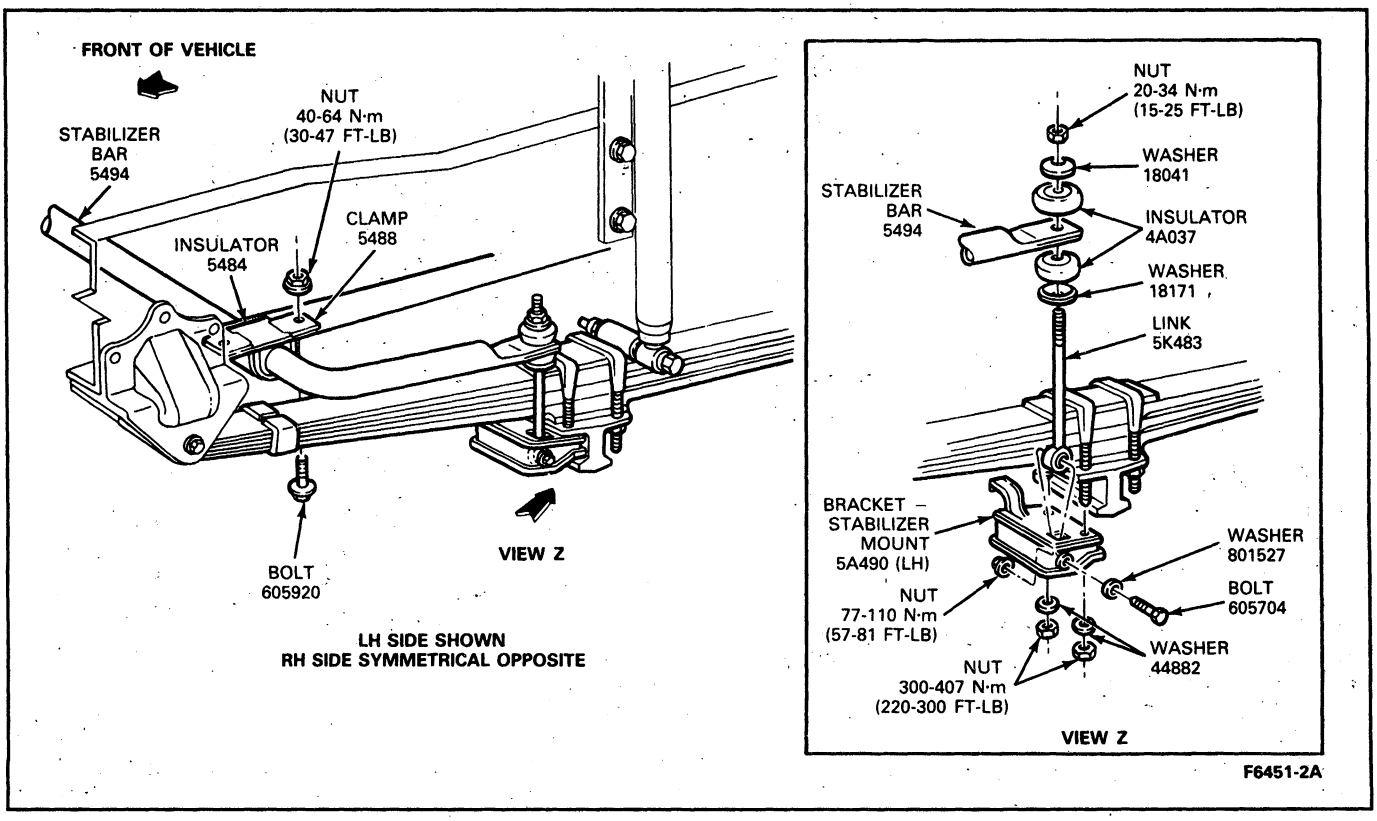


FIG. 30 Front Stabilizer Bar Installation—F-Super Duty Commercial Stripped Chassis and Motor Home Chassis Vehicles

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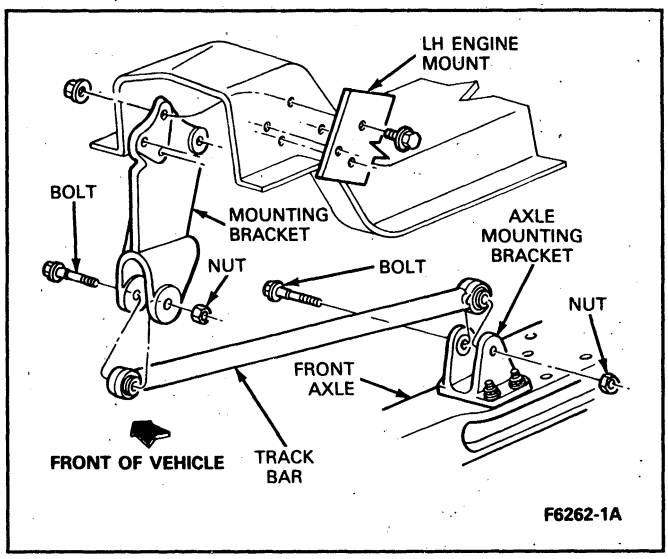


FIG. 31 Track Bar Installation—F-Super Duty

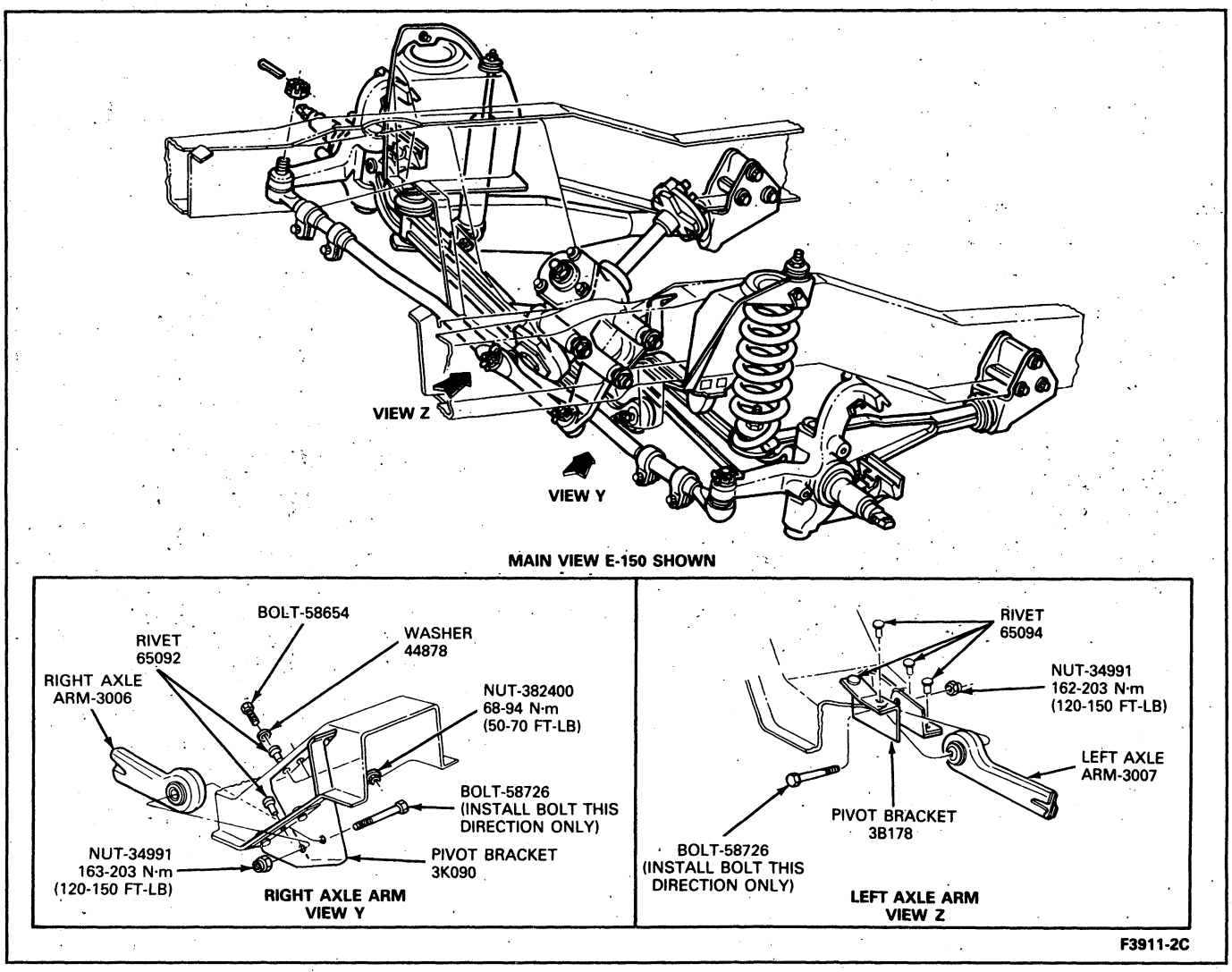


FIG. 32 Axle Arm Installation—E-150—E-250—E-350

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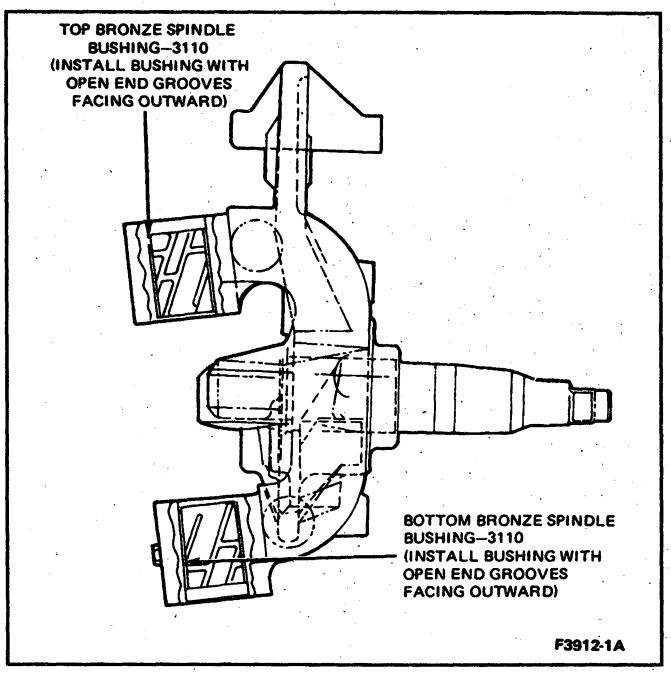


FIG. 33 Spindle Bushing Installation—Cutaway View

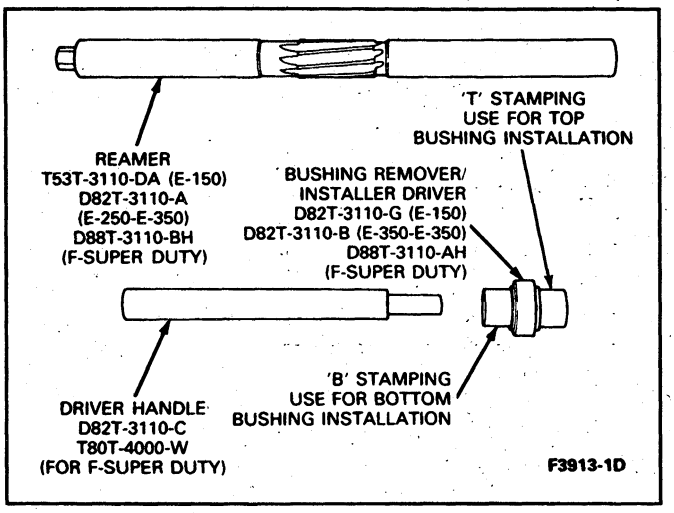


FIG. 34 Spindle Bushing Removal/Installation Tools

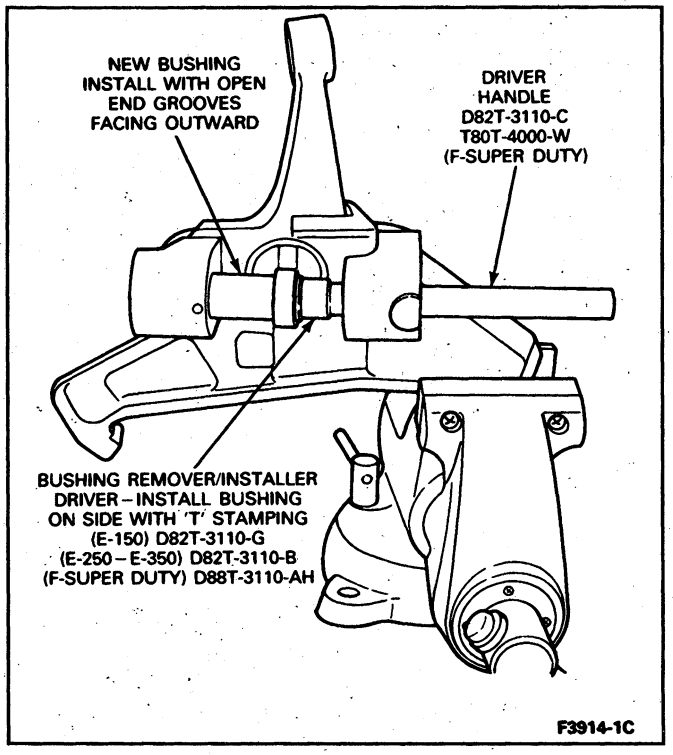


FIG. 35 Top Spindle Bushing Removal and Installation

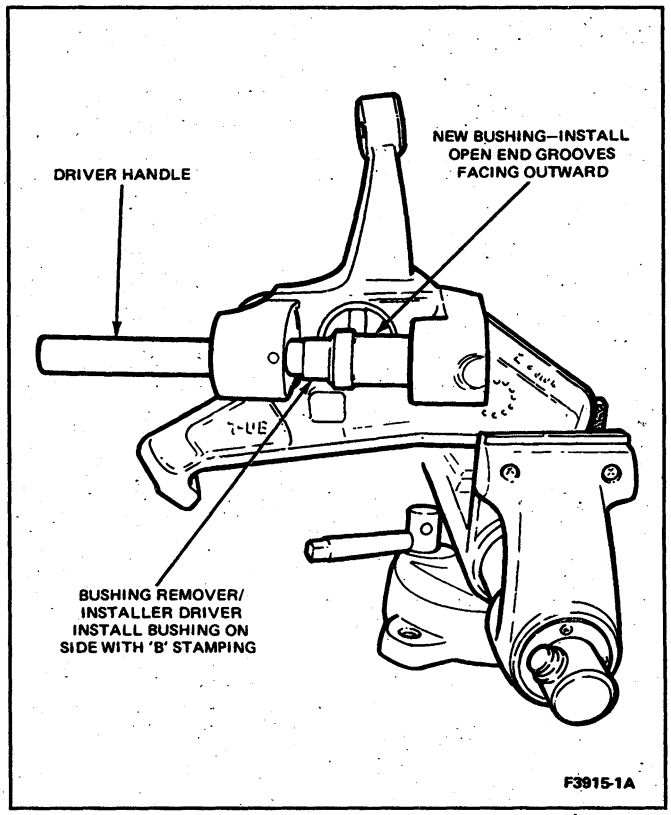


FIG. 36 Bottom Spindle Bushing Removal and Installation

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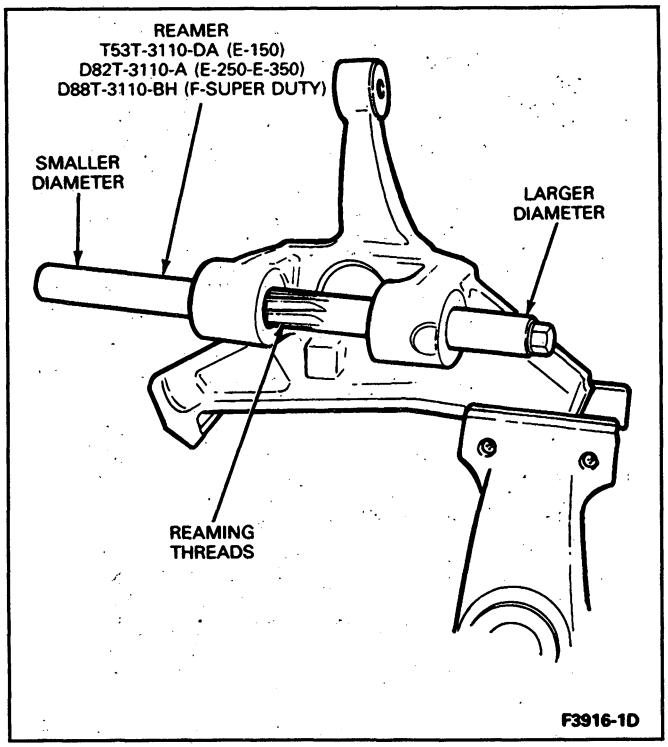


FIG. 37 Reaming Bushings

SPECIFICATIONS

Description	F-150 (4x2)		F-250 — F-350 (4x2)		E-150 — E-250 — E-350	
	N•m	Ft-Lbs	N•m	Ft-Lbs	N•m	Ft-Lbs
Axle to Pivot Bracket Nut and Bolt	162-203	120-150	162-203	120-150	162-203	120-150
Axle to Radius Arm Nut and Bolt	365-446	269-329	365-446	269-329	326-433	240-320
Axle to Upper Ball Joint Pinch Bolt Nut	65-88	48-65	65-88	48-65	—	—
Axle Pivot Bracket (Left) to Upper Frame Nut	104-149	77-109	104-149	77-109	—	—
Axle Pivot Bracket (Left) Side Retainer to Frame Nut	104-149	77-109	104-149	77-109	—	—
Axle Pivot Bracket (Right) to Frame Nut	—	—	—	—	68-94	50-70
Ball Joint (Lower) to Axle Nut	129-149	95-110	—	—	—	—
Coil Spring to Lower Retainer Nut	95-135	70-100	95-135	70-100	95-135	70-100
Coil Spring Upper Retainer to Spring Seat Nut and Bolt	18-24	13-18	18-24	13-18	28-40	20-30
Jounce Bumper to Frame Bolt	19-29	14-22	19-29	14-22	28-40	20-30
Lock Pin to Spindle Nut	—	—	—	—	52-84	38-62
Radius Arm to Rear Bracket Nut	109-162	80-120	109-162	80-120	109-162	80-120
Radius Arm Rear Bracket to Frame Bolt	105-135	77-100	105-135	77-100	102-142	75-105
Shock Absorber to Lower Bracket Nut and Bolt	71-100	52-74	71-100	52-74	55-81	40-60
Shock Absorber to Upper Spring Seat Nut	34-47	25-35	34-47	25-35	25-37	18-28
Shock Absorber Bracket to Radius Arm Nut and Bolt	37-50	27-37	37-50	27-37	95-128	70-95
Spindle Pin Plug to Spindle Nut	—	—	48-67	35-50	48-67	35-50
Stabilizer Bar Link to Bracket	71-100	52-74	71-100	52-74	55-81	40-60
Stabilizer Bar Link to Stabilizer Bar	71-100	52-74	71-100	52-74	25-37	18-28
Stabilizer Bar Retainer to Frame Crossmember Mounting Bracket	37-50	27-37	37-50	27-37	21-33	15-25
Steering Linkage to Spindle Nut	94-135	70-100	94-135	70-100	94-135	70-100

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F-SUPER DUTY CHASSIS CAB FRONT SUSPENSION TORQUE SPECIFICATIONS

Description	N•m	Ft-Lbs
Drag Link to Pitman Arm Nut	70-100	52-74
Steering Linkage to Spindle Nut	70-100	52-74
Spring Shackle to Frame Nut	203-285	150-210
Spring to Spring Shackle Nut	163-203	120-150
Axle to Spring U-Bolt Nut	203-285	150-210
Tracking Bar Retaining Nuts and Bolts	163-203	120-150
Tracking Bar Mounting Bracket Nuts and Bolts	104-149	77-110
Jounce Bumper Bracket U-Bolt Nuts	70-100	52-74
Jounce Bumper Bracket Mounting Nuts	25-40	18-30
Spring to Rear Hanger Bracket	203-285	150-210
Stabilizer Link Mounting Bracket Nut	48-68	35-50
Stabilizer Link to Stabilizer Bar Nut	21-32	15-25
Upper Shock Bracket Nuts	70-100	52-74
Upper and Lower Shock to Bracket Nuts	70-100	52-74
Linkage Adjusting Clamp Nut	81-122	60-90

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TORQUE SPECIFICATIONS F-SUPER DITY COMMERCIAL STRIPPED CHASSIS AND MOTOR HOME CHASSIS VEHICLES

	Torque Range	
Description	N•m	Ft-Lb
Shock Absorber to Upper Shock Mount	300-407	220-300
Shock Absorber Upper Mount to Frame	300-407	220-300
Shock Absorber to Lower Mount	300-407	220-300
Leaf Spring U-Bolt Nuts	300-407	220-300
Jounce Bumpers to Frame or Bracket	40-64	30-46
Leaf Spring Front Shackle Through Bolt	200-280	148-207
Leaf Spring Rear Shackle Through Bolt	100-150	74-110
Steering Arm to Tie Rod, Castellated Nut	75-105	55-77
Steering Stop Bolt Lock Nut	50-70	37-52
Steering Drag Link to Steering Arm Castellated Nut	75-105	55-77
Steering Arm, Castellated Nut	75-105	55-77
Spindle Pin Lock Bolt, Nut	50-70	37-52
Stabilizer Bar Clamp to Frame	40-64	30-47
Stabilizer Link Through Bolt	77-110	57-81
Stabilizer Link to Stabilizer Bar, Nut	20-34	15-25

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SPECIAL SERVICE TOOLS

Number	Description	Application
D81T-3010-A	Ball Joint Service Set (Adapter Tools)	F-150-250-350 (4x2)
D81T-3010-B	Remover Tool	F-150-250-350 (4x2) Twin I-Beam Axles
D82T-3110-A	Reamer	Spindle Bushing Service — E-250 — E-350
D82T-3110-B	Bushing Remover/Installer Driver	Spindle Bushing Service — E-250 — E-350
D82T-3110-C	Driver Handle	Spindle Bushing Service
T80T-4000-W	Driver Handle	Spindle Bushing Service — F-Super Duty
T53T-3110-DA	Reamer	Spindle Bushing Service — E-150
D82T-3110-G	Bushing Remover/Installer Driver	Spindle Bushing Service — E-150
D79P-3283-A	Tie Rod Adjusting Tool	Universal
TOOL-3290-D	Tie Rod End Remover	Universal
D80T-4020-F49	Gauge Tube (2.892 O.D.)	Replaces T79P-4020-A16
T74P-4635-C	C-Frame Assembly	Ball Joint Removal and Installation
T78P-5638-A	Suspension Bushing Service Set	Axle Pivot Bushing
T80T-5638-A2	Front Suspension Bushing Tool	Use with T78P-5638-A
T85T-5638-A	I-Beam Bushing Remover/Replacer	I-Beam Bushing Service
D88T-3110-B	Reamer	F-Super Duty
D88T-3110-A	Bushing Remover/Installer Driver	F-Super Duty

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SECTION 14-22 Front Suspension—4-Wheel Drive

SUBJECT	PAGE
DESCRIPTION	
Front Shock Absorber	14-22-1
Front Suspension	14-22-1
Bronco, F-150 (4x4)	14-22-1
F-250 (4x4) with Dana 44 or 50 Front Drive Axle	14-22-1
F-350 (4x4) with Dana 60 Monobeam Front Drive Axle	14-22-1
REMOVAL AND INSTALLATION	
Axle Housing Pivot Bushing	14-22-7
Axle Pivot Bracket	14-22-7
F-150 (4x4) and Bronco	14-22-7
F-250—(4x4)	14-22-8
Front Driving Axle	14-22-7
Front Shock Absorber	14-22-5
F-150 (4x4) and Bronco Equipped with Quad Front Shock Absorbers	14-22-5

SUBJECT	PAGE
REMOVAL AND INSTALLATION (Cont'd)	
Front Shock Absorber (Cont'd)	
F-250/F-350 (4x4)	14-22-5
Front Spring	14-22-1
F-150 (4x4), Bronco	14-22-1
F-250, F-350 (4x4)	14-22-5
Front Stabilizer Bar	14-22-8
Bronco and F-150 (4x4)	14-22-8
F-250 (4x4)	14-22-8
Front Wheel Spindle	14-22-5
Jounce Bumper	14-22-8
Radius Arm	14-22-7
F-150 (4x4), Bronco	14-22-7
SPECIFICATIONS	14-22-12
VEHICLE APPLICATION	14-22-1

VEHICLE APPLICATION

Applies to F-150 Through F-350 (4x4) and Bronco.

DESCRIPTION

Front Suspension

Bronco, F-150 (4x4)

The Bronco and F-150 (4x4) Independent Front Suspension (IFS) system (Fig. 1) is composed of a two-piece front driving axle assembly, two coil springs and two radius arms.

The front driving axle consists of two independent axle arm assemblies. One end of each axle arm assembly is anchored to the frame. The other end of each axle arm assembly is supported by the coil spring and radius arm.

F-250 (4x4) with Dana 44 or 50 Front Drive Axle

The F-250 (4x4) Independent Front Suspension (IFS) system (Fig. 2) has a Dana 44 or 50 two-piece driving axle attached to the frame with two semi-elliptic, leaf-type springs. Each spring is clamped to the axle arm assembly with two U-bolts. The rear eye of the spring is attached to the hanger bracket. The front of the spring is attached to a shackle bracket.

The shock absorbers are the direct, double-acting type. They are attached to a frame bracket at the top and to the U-bolt spacer plate at the bottom.

F-350 (4x4) with Dana 60 Monobeam Front Drive Axle

The F-350 (4x4) has a Dana 60 Monobeam one-piece driving axle attached to the frame with two semi-elliptical, leaf-type springs (Fig. 3). Each spring is clamped to the axle assembly with two U-bolts. The rear eye of the spring is attached to the hanger bracket. The front of the spring is attached to a shackle bracket. On the right spring cap, a tracking bar is attached with the opposite end mounted on the crossmember.

The shock absorbers are the direct double-acting type. They are attached to a frame bracket at the top and to the U-bolt spacer plate at the bottom.

Front Shock Absorber

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

The hydraulic shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both on compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

REMOVAL AND INSTALLATION

Front Spring

F-150 (4x4), Bronco

Removal

1. Raise the vehicle on a hoist and remove the shock absorber-to-lower bracket attaching bolt and nut (Figs. 1 and 4).
2. Remove spring lower retainer attaching nuts from inside of the spring coil.
3. Remove spring upper retainer attaching screw and remove the upper retainer.
4. Position safety stands under the frame side rails and lower the axle enough to relieve tension from the spring.

   NOTE: The axle must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and

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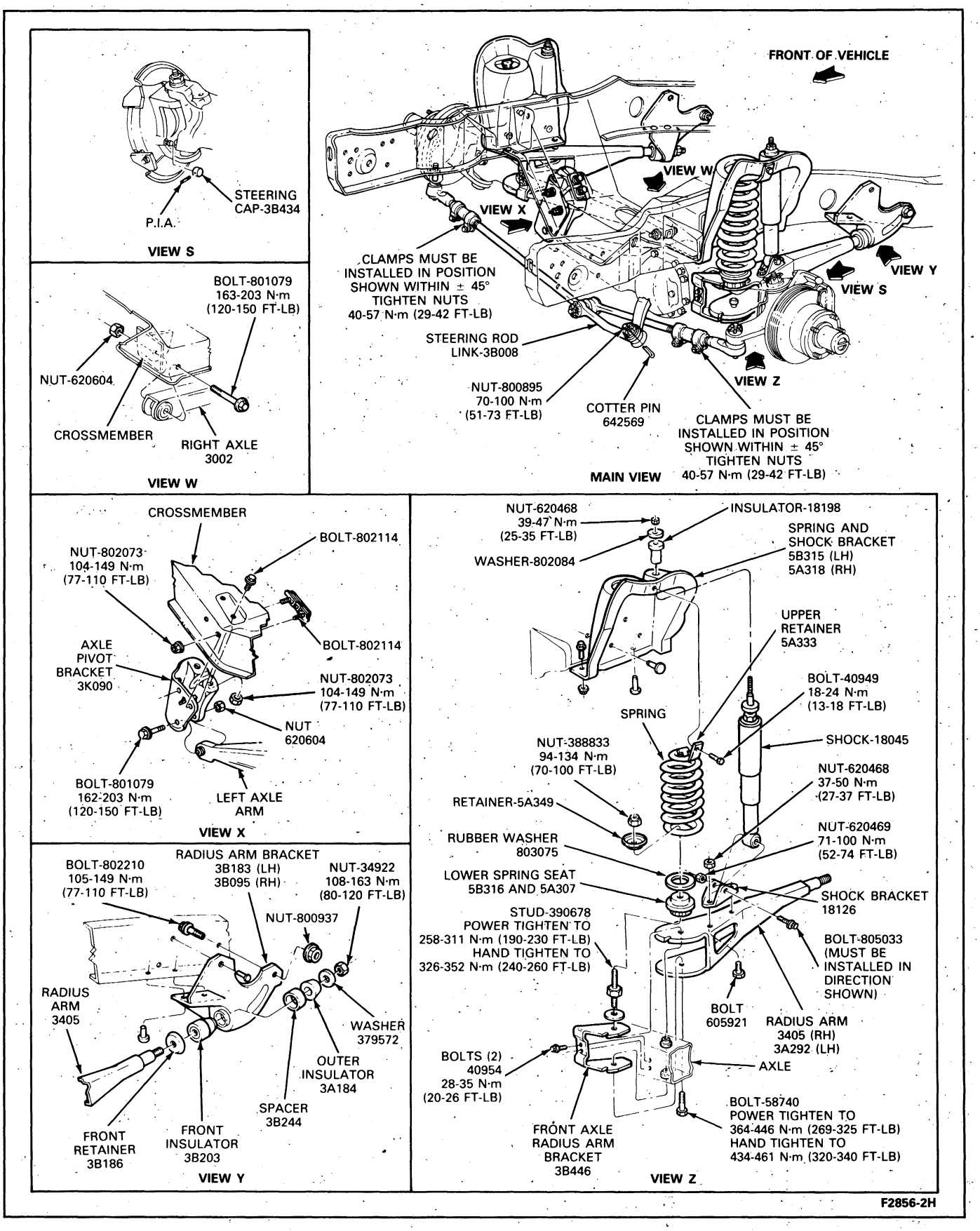


FIG. 1 Front Suspension Bronco, F-150 (4x4)

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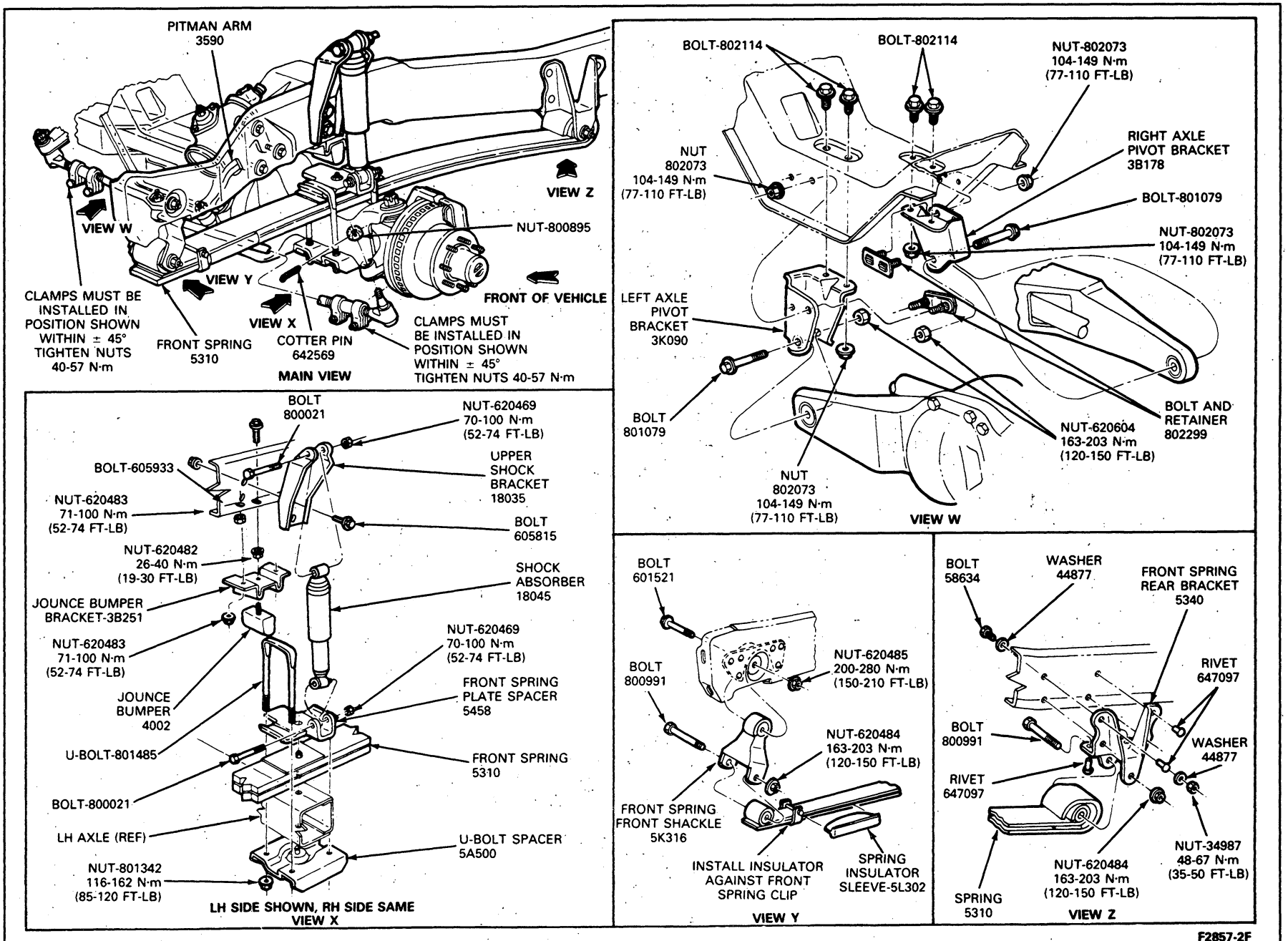


FIG. 2 Front Suspension—F-250 (4x4) with Dana 44-IFS-HD and 50 IFS—Front Drive Axle

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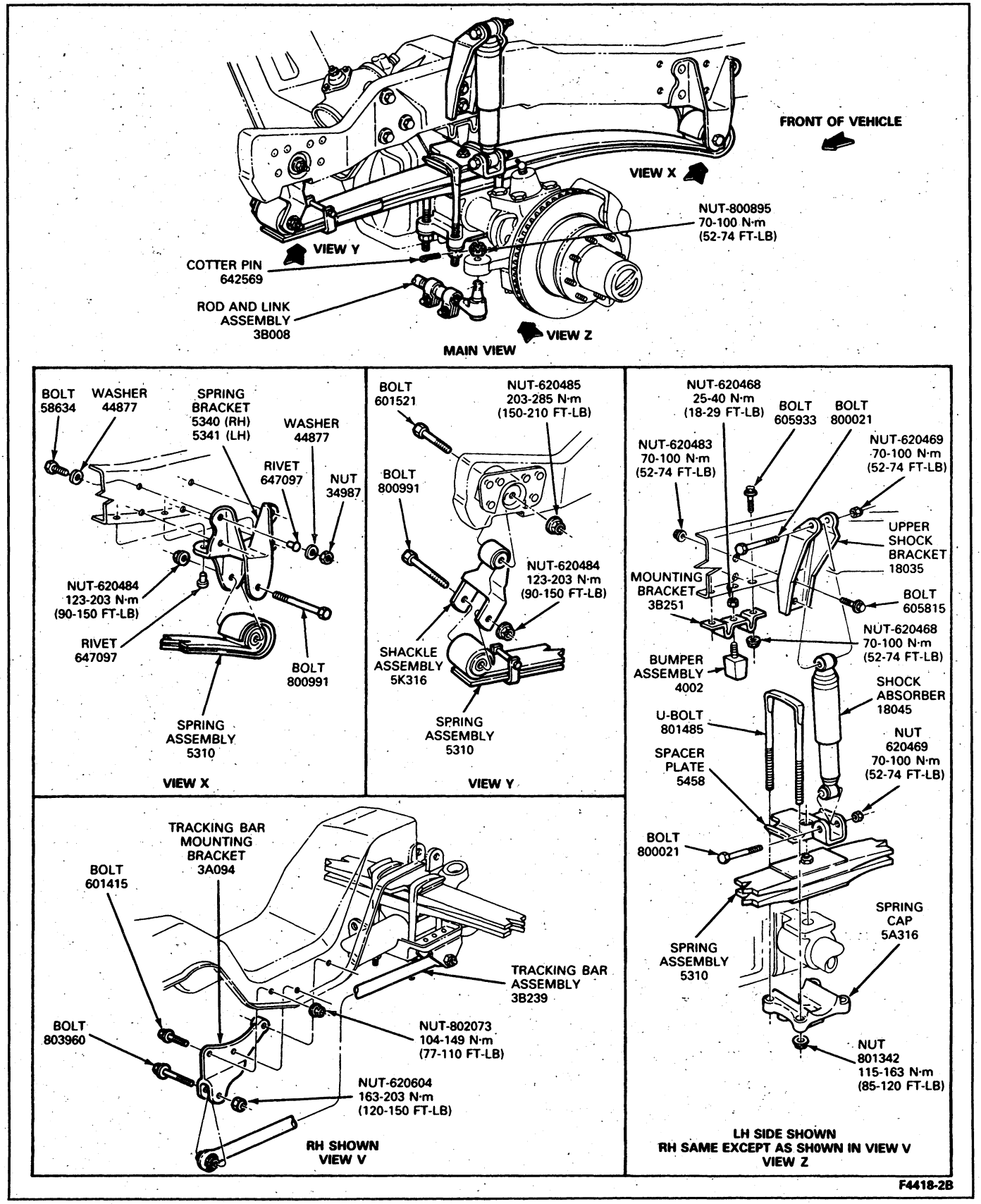


FIG. 3 Front Suspension—F-350 (4x4) with Dana Model 60 Monobeam Front Drive Axle

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installation of the spring, the disc brake caliper must be removed from the spindle according to the procedures specified in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.

5. Remove the spring, lower retainer, and lower the spring from the vehicle.

Installation

1. Place the spring in position and slowly raise the front axle. Insure springs are positioned correctly in the upper spring seats.
2. Position the spring lower retainer over the stud and lower seat and install the attaching nut 94-134 N·m (70-100 ft-lbs).
3. Position the upper retainer over the spring coil and install the attaching screws 18-24 N·m (13-18 ft-lbs).
4. Position the shock absorber to the lower bracket and install the attaching bolt and nut with the bolt head towards the tire. Tighten the bolt and nut to 71-100 N·m (52-74 ft-lbs) as listed at the end of this Section. Remove safety stands and lower the vehicle.

Front Spring

F-250, F-350 (4x4)

Removal

1. Raise the vehicle frame until the weight is off the front spring with the wheels still touching the floor. Support the axle to prevent rotation.
2. Disconnect the lower end of the shock absorber from the U-bolt spacer. Remove the U-bolts, U-bolt cap and spacer. For those vehicles equipped with a Dana Model 60 Monobeam front drive axle, remove the two bolts which retain the tracking bar to the right spring cap and tracking bar mounting bracket (Figs. 2 and 3).
3. Remove the nut from the hanger bolt retaining the spring at the rear. Drive out the hanger bolt.
4. Remove the nut connecting the front shackle and spring eye. Drive out the shackle bolt and remove the spring.

Installation

1. Position the new spring on the spring seat. Install the shackle bolt, (Fig. 2), through the shackle and spring 163-203 N·m (120-150 ft-lbs).
2. Position the rear of the spring to allow the rear hanger bolt to be installed. Install the nut and tighten to 163-203 N·m (120-150 ft-lbs).
3. Position the U-bolt spacer and place the U-bolts in position through holes in the spring seat cap. Install but do not tighten the U-bolt nuts. For those vehicles equipped with a Dana Model 60 Monobeam front drive axle, with the vehicle in the "CURB" position, connect the tracking bar to the tracking bar mounting bracket and right spring cap.
4. Connect the lower end of the shock absorber to the U-bolt spacer.
5. Lower the vehicle and tighten the U-bolt nuts to 115-163 N·m (85-120 ft-lbs).

Front Wheel Spindle

Refer to Section 15-34, Dana Model 44 and 50 Front Driving Axle and Section 15-32, Dana Model 60 Monobeam Front Drive Axle under Steering Knuckle, Removal and Installation for spindle replacement on 4-wheel drive front axles.

Front Shock Absorber

F-250/F-350 (4x4)

Refer to Figs. 2 and 3.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi) for 1 inch and 1 3/16 inch bore, and 1034 kPa (150 psi) for 1 3/8 inch bore. Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Remove the nut and bolt that retains the shock absorber to the upper shock bracket.
2. Disconnect the lower end of the shock absorber from the U-bolt plate (bolt and nut).
3. Compress the shock absorber and remove.

Installation

1. Insert shock absorber into the upper shock bracket. Insert bolt and tighten nut to 70-100 N·m (52-74 ft-lbs).
2. Attach the lower end of the shock absorber to the U-bolt plate by installing the nut and bolt. Tighten to 70-100 N·m (52-74 ft-lbs).

F-150 (4x4) and Bronco Equipped with Quad Front Shock Absorbers

Refer to Fig. 4.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi) for 1 inch and 1 3/16 inch bore and 1034 kPa (150 psi) for 1 3/8 inch bore. Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. For forward and rearward of front axle shock absorber installation, insert a wrench to hold the upper shock absorber retaining nut. Loosen the stud by turning the hex provided on the exposed (lower) part of the stud and remove nut and washer.
2. Disconnect the lower end of the shock absorber from the bracket, bolt and nut for rearward of front axle installation, and nut and washer for forward of front axle installation.
3. Compress the shock absorbers and remove.
4. Cut out insulators from upper spring seat.

Installation

1. Insert new one-piece insulators into the top surface of the upper spring seat (use soap solution to aid in installation).
2. Insert shock absorber stud through insulator. Replace steel washer and hand start nut. While holding the nut as described in Step 1 of Removal,

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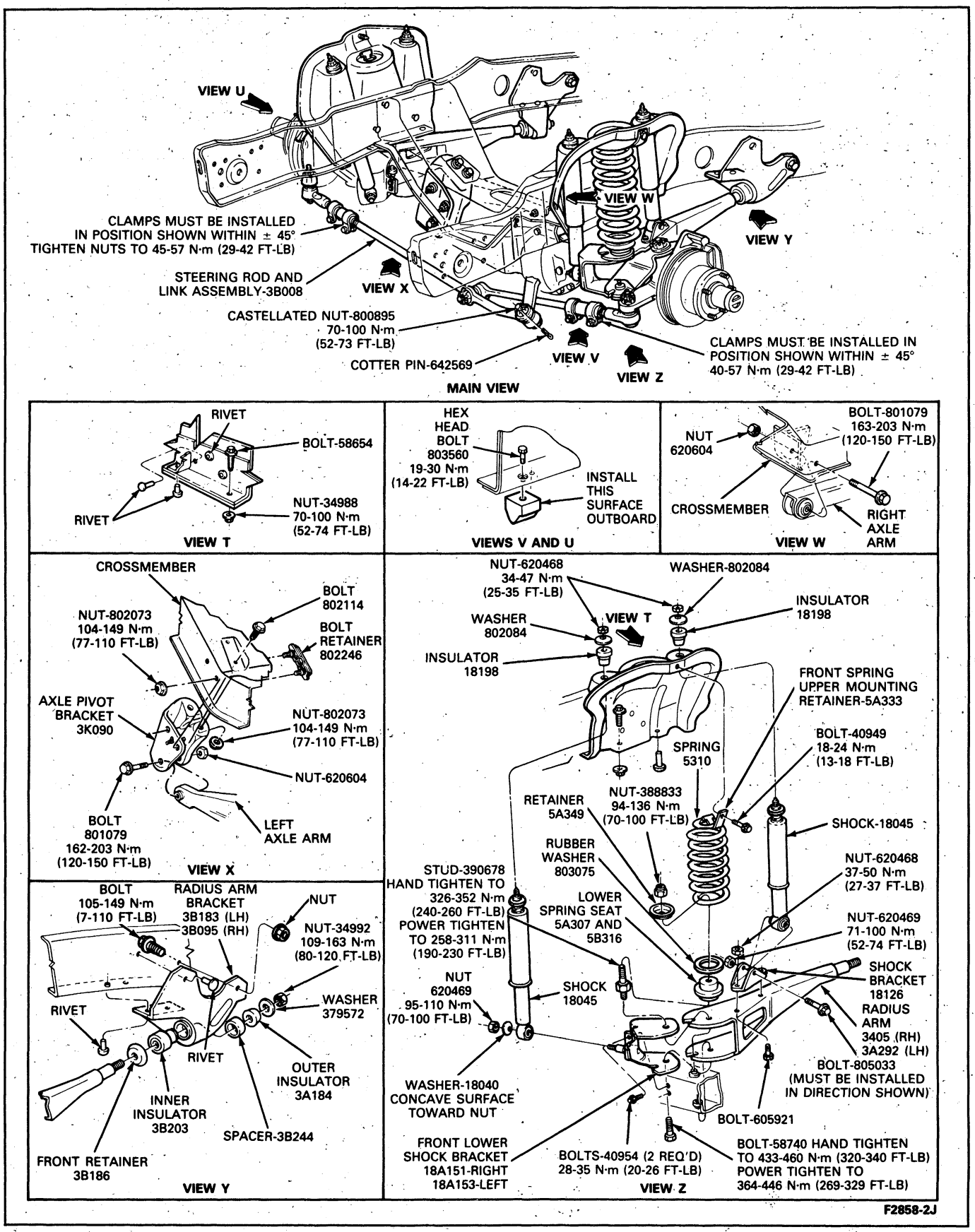


FIG. 4 Quad Shocks—Installation—Bronco and F-150 (4x4)

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tighten to 34-47 N·m (25-35 ft-lbs) by turning the hex provided on the stud.

3. For the rearward of front axle shock absorber installation, attach the lower end of the shock absorber to the bracket by installing the nut and bolt with the bolt head installed toward the tire. Tighten to 70-100 N·m (52-74 ft-lbs). For the forward of front axle shock absorber installation, attach the lower end of the shock absorber to the bracket by installing washer (concave surface to nut) and tighten nut to 95-136 N·m (70-100 ft-lbs).

Front Driving Axle

Refer to Section 15-34, Dana Model 44 and 50 Front Driving Axle and Section 15-32, Dana Model 60 Monobeam Front Drive Axle for front axle removal and installation procedures on Bronco, F-150—F-250—F-350 (4x4) 4-wheel drive vehicles.

Radius Arm

F-150 (4x4), Bronco

Removal

Refer to Figs. 1 and 4.

1. Raise the vehicle and position safety stands under the frame side rails and a jack such as Rotunda Hydraulic Floor Jack 077-00002 or equivalent under the axle.
2. Remove the front wheel and tire assembly. Refer to Section 11-02, Wheels and Tires, for procedure.
3. Disconnect the front stabilizer bar (if so equipped) at the stabilizer link.
4. Remove the shock absorber-to-lower bracket attaching bolt and nut and pull the shock absorber free of the radius arm.
5. Remove spring lower retainer attaching bolt from inside of the spring coil.
6. Loosen the axle pivot bolt.
7. Remove the nut attaching the radius arm to the frame bracket and remove the radius arm rear plastic spacer and insulator. Lower the axle, remove the lower spring retainer, insulator and spring seat and allow the axle to move forward.

   NOTE: The axle must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring seat, the disc brake caliper must be removed from the spindle according to the procedures specified in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.
8. Remove the two bolts attaching the front axle to radius arm bracket to axle tube.
9. Remove the bolt and stud attaching radius arm to axle.
10. Remove the front axle radius arm bracket.
11. Move the axle forward and remove the radius arm from the axle. Remove the radius arm from the frame bracket.

Installation

1. Clean all the mating surfaces between the radius arm, axle and bracket prior to re-assembly.
2. Position the forward washer and insulator on the rear of the radius arm and insert the radius arm into the frame bracket.
3. Position the rear spacer, insulator and washer on the radius arm and loosely install the attaching nut.
4. Position the radius arm and front axle to radius arm bracket on the axle.
5. Loosely install a new stud and bolt attaching the radius arm to the axle.

   NOTE: New stud and bolt are required because of the adhesive coating on the original bolts. If new fasteners are not available, thoroughly clean the old fasteners and apply Loctite No. 242 or equivalent to the threads of the fasteners.
6. Tighten the radius arm rear attaching nut to 109-163 N·m (80-120 ft-lbs).
7. Install and tighten the bracket to axle attachment screws to 27-35 N·m (20-26 ft-lbs).
8. Tighten the radius arm (hand tighten) to axle lower bolt to 432-460 N·m (320-340 ft-lbs) and the upper stud type bolt to 324-351 N·m (240-260 ft-lbs) (hand tighten).
9. Position the spring lower seat with the locating tab positioned in the radius arm notch spring insulator and retainer to the spring and axle. Install the lower spring retainer and tighten nut to 94-134 N·m (70-100 ft-lbs).
10. Position the shock absorber to the lower bracket and install the attaching bolt and nut and tighten to 71-100 N·m (52-74 ft-lbs).

    NOTE: It is important that the bolt be installed with the head toward the tire to maximize clearance to brake system components.
11. Connect the front stabilizer bar (if so equipped) to the stabilizer link. Tighten nut to 70-100 N·m (52-74 ft-lbs).
12. Reinstall front calipers if removed. Inspect brake hoses for damage.
13. Reinstall the front wheel and tire assembly. Refer to Section 11-02, Wheels and Tires, for procedure.
14. Lower vehicle and, with the weight on the suspension, tighten axle pivot bushing bolt and nut to 163-203 N·m (120-150 ft-lbs).

Axle Housing Pivot Bushing

Removal and Installation

Refer to Section 15-34, Dana Models IFS-44, IFS-44HD and IFS-50 Front Driving Axle and 15-32, Dana Model 60 Monobeam Front Drive Axle, under Axle Housing Pivot Bushing—Removal and Installation for correct service procedures on Bronco—F-150—F-250—F-350 (4x4) vehicles.

Axle Pivot Bracket

F-150 (4x4) and Bronco

Refer to Fig. 1.

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Removal

1. Remove the front axle as described in the Removal and Installation portion of Section 15-34, Dana Models IFS-44, IFS-44HD and IFS-50 Front Driving Axle.
2. Remove the retainer and bolts attaching the pivot bracket to frame. Refer to View X in Fig. 1.

Installation

1. Position the axle pivot bracket to the crossmember and loosely assemble the bolts, retainer assembly and nuts. Do not tighten at this time.

   NOTE: The two rearward vertical fasteners must be installed with bolt heads adjacent to the engine oil pan to maintain required clearance. The bolt and retainer assembly must be installed with bolt heads on the inside of the pivot bracket surface.
2. To ensure correct positioning of the axle pivot bracket, tighten the two forward fasteners to 149 N·m (110 ft lbs) first. Then tighten the two rearward vertical nuts and bolts in the top of the crossmember to 149 N·m (110 ft lbs).
3. Install the axle, front spring, radius arm, and wheel spindle as described in this Section.

Axle Pivot Bracket

F-250—(4x4)

Refer to Fig. 2.

Removal

1. Place supports securely under the axle arms and remove the axle pivot bolts.

   WARNING: IF THE AXLE ARMS ARE NOT SECURELY SUPPORTED, THE AXLE ARMS WILL DROP SUDDENLY 4-6 INCHES.
2. If necessary, pry the axle out of the bracket and lower the axle.
3. Remove and discard all axle pivot bracket to crossmember fasteners and remove the axle pivot brackets (Refer to View W, Fig. 2).

   NOTE: If necessary, raise the engine to provide access to the vertical fasteners in the top of the crossmember as follows:

   A. Loosen the right and left engine mount bolts.
   B. Align the fan blade to clear the shroud and raise the engine 2 inches. Make sure the air cleaner does not come in contact with the firewall.
   C. Block engine securely in place.

Installation

1. Position the axle pivot bracket to the crossmember and loosely assemble the bolts retainer assembly and nuts. Do not tighten at this time.

   NOTE: The vertical fasteners for each pivot bracket must be installed with bolt heads adjacent to the engine oil pan to maintain required clearance. Horizontal fasteners must be installed with the bolt heads on the inside surface of the pivot brackets. Refer to View W in Fig. 2.
2. To ensure correct positioning of the axle pivot brackets, tighten the horizontal fasteners in the side of the crossmember first. Tighten to 149 N·m (110 ft-lbs). Tighten the vertical fasteners in the top of the crossmember to 149 N·m (110 ft-lbs).
3. Position the axles in the pivot bracket. Install the pivot bolt and tighten nut to 200 N·m (150 ft-lbs).
4. Remove the blocks under the engine and lower the engine into position. Tighten the bolts to specification listed in the appropriate engine Section in Group 21 or Group 22, Light Truck Engine Shop Manual (Volume B)*.

Jounce Bumper

Refer to Figs. 2 and 3.

Removal

1. Remove the hex head bolt that holds jounce bumper to frame. Remove jounce bumper.

Installation

1. Position jounce bumper in forward set of holes in frame.

   NOTE: The rearward set of holes on the right bumper only are for F-150—F-350 (4x2) vehicles only. The forward set of holes are for F-150 (4x4) and Bronco only.
2. Install the hex head bolt and tighten to 19-29 N·m (14-22 ft-lbs).

Front Stabilizer Bar

Bronco and F-150 (4x4)

Removal

Refer to Fig. 5.

1. Remove nuts, bolts and washers connecting the stabilizer bar to connecting links. Remove nuts and bolts of the stabilizer bar retainer.
2. Remove stabilizer bar retainer.
3. Remove the stabilizer bar and insulator.

NOTE: The stud does not have to be removed.

The bracket to frame assembly may be removed but not the #1A crossmember.

Installation

1. Install insulators on stabilizer bar.
2. Position stabilizer bar with insulators to mounting brackets and install attaching nuts and bolts. Tighten retainer nuts to 37-50 N·m (27-37 ft-lbs).
3. Reinstall link to stabilizer attaching bolt and nut. Tighten to 71-100 N·m (52-74 ft-lbs).

F-250 (4x4)

Removal

Refer to Fig. 6.

1. Remove bolts, washers and nuts securing the links to spring seat caps (both sides). For those vehicles equipped with a Dana Model 60 Monobeam Front Drive axle, remove the nut, washer, and bolt securing the links to the mounting brackets (both sides). Remove nuts, washers and insulators connecting links to stabilizer bar. Remove link assemblies.

*May be purchased as a separate item.

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2. Remove nuts and bolts securing retainers to mounting bracket and remove retainers.
3. Remove stabilizer bar.

Installation

1. To reinstall, replace the components in reverse order of disassembly without tightening bolts.
2. Tighten nuts connecting links to spring seat caps on both sides, 70-100 N·m (52-74 ft-lbs).
3. Tighten nuts connecting links to stabilizer bar, 21-33 N·m (15-25 ft-lbs).
4. Tighten nuts and bolts connecting retainers to mounting bracket, 34-48 N·m (25-35 ft-lbs).

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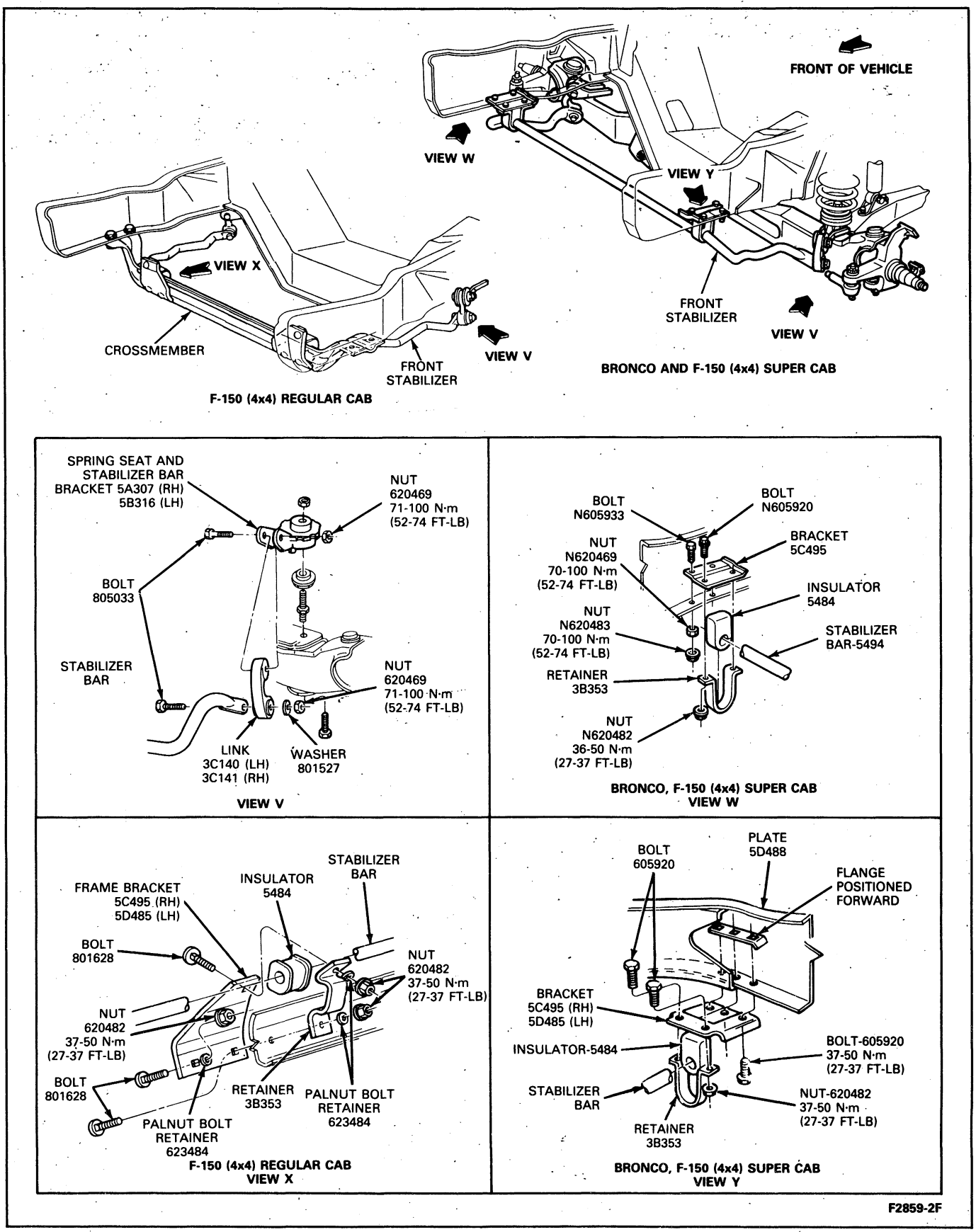


FIG. 5 Front Stabilizer Bar Installation—F-150 (4x4), Bronco

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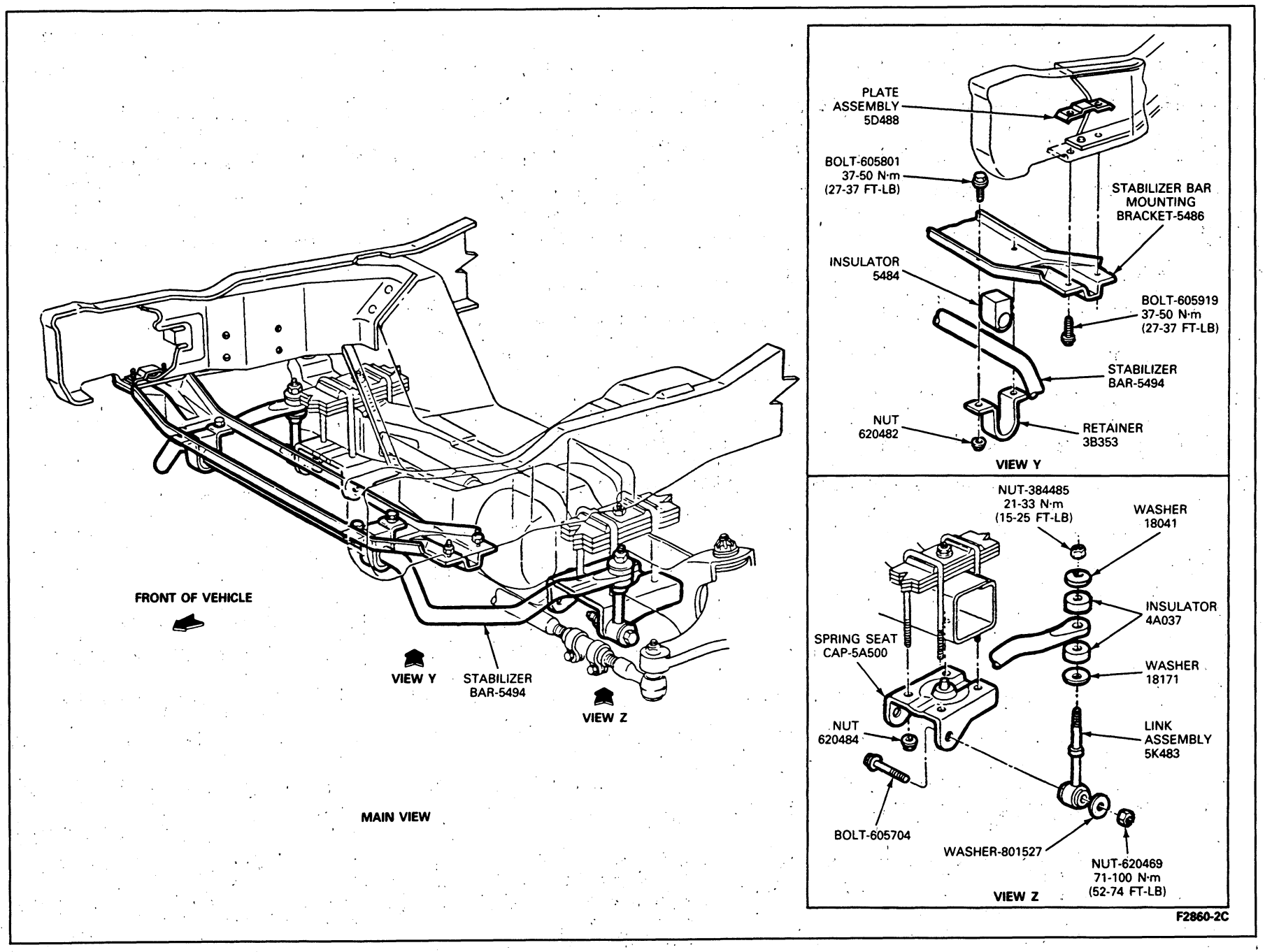


FIG. 6 Front Stabilizer Bar Installation—F-250 (4x4) with Dana 44 IFS-HD and 50 IFS—Front Drive Axle

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SPECIFICATIONS

FRONT SUSPENSION TORQUE LIMITS — F-150/F-250 (4x4), BRONCO

Description	Model	Torque	
		(ft-lbs)	N-m
Radius Arm to Axle, Upper Stud	Bronco, F-150 (4x4)	240-260 (Hand Tighten)	326-352
Radius Arm to Axle, Lower Belt	Bronco, F-150 (4x4)	320-340 (Hand Tighten)	434-461
Front Spring to Axle U-Bolt	F-250 (4x4)	85-120	115-163
Front Spring Assembly to Hanger Bracket	F-250 (4x4)	120-150	163-203
Front Spring Shackle to Shackle Bracket	F-250 (4x4)	150-210	203-285
Front Spring to Shackle	F-250 (4x4)	120-150	163-203
Radius Arm to Bracket	Bronco, F-150 (4x4)	80-120	109-163
Spring Retainer to Upper Spring Seat	Bronco, F-150 (4x4)	Screw 13-18	18-24
Lower Spring Retainer to Radius Arm	Bronco, F-150 (4x4)	70-100	94-134
Front Shock Bracket to Frame	F-250 (4x4)	52-74	71-100
Front Shock to Shock Bracket — Lower	Bronco, F-150 (4x4)	52-74	71-100
Front Shock Absorber Stud — Upper	Bronco, F-150 (4x4)	25-35	34-47
Front Shock to Front Spring Plate Spacer — Lower	F-250 (4x4)	52-74	70-100
Front Shock to Bracket — Upper	F-250 (4x4)	52-74	70-100
Front Jounce Bumper to Bumper Bracket	F-250 (4x4)	19-30	26-41
Bumper Bracket to Frame	F-250 (4x4)	52-74	71-100
Front Jounce Bumper to Upper Spring Seat	Bronco, F-150 (4x4)	14-22	19-30
Radius Arm Pivot Bracket to Frame	Bronco, F-150 (4x4)	77-110	104-149
Stabilizer Bar Link to Bracket	Bronco, F-150 (4x4)	52-74	71-100
Stabilizer Bar Link to Stabilizer Bar	Bronco, F-150 (4x4)	52-74	71-100
Stabilizer Bar Retainer to Bracket and Bracket to Frame	Bronco, F-150 (4x4) — Super Cab	27-37	37-50
Stabilizer Bar Retainer to Bracket	Bronco, F-150 (4x4) Super Cab	27-37	37-50
Stabilizer Bar Bracket to Frame (R.H.)	Bronco, F-150 (4x4) Super Cab	52-74	71-100
Stabilizer Bar Retainer to Crossmember and Mounting Bracket	F-150 (4x4) Regular Cab	27-37	37-50
Axle Pivot Bracket to Frame	F-150 (4x4) Bronco	77-110	104-149
Axle Pivot Bracket to Frame	F-250 (4x4)	77-110	104-149

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FRONT SUSPENSION TORQUE LIMITS — F-350 (4x4) WITH DANA 60 MONOBEAM FRONT DRIVE AXLE

Description	Torque	
	(Ft-Lb)	N-m
Bumper Mounting Bracket to Frame	52-74	70-100
Bumper to Mounting Bracket	18-29	25-40
Front Shock Bracket to Frame	52-74	70-100
Front Shock to Shock Bracket — Upper	52-74	70-100
Front Shock to Spacer Plate Bracket — Lower	52-74	70-100
Front Spring Assembly to Shackle	120-150	163-203
Front Spring Assembly to Spring Bracket	120-150	163-203
Front Spring Shackle to Frame	150-210	203-285
Stabilizer Bar Link Assembly Mounting Bracket to Frame	35-50	48-68
Stabilizer Bar Link Assembly to Mounting Bracket	52-74	70-100
Stabilizer Bar to Link Assembly	15-25	21-33
Tie Rod End to Spindle Arm	52-74	70-100
Tracking Bar Assembly to Mounting Bracket	120-150	163-203
Tracking Bar Mounting Bracket to Crossmember	77-110	104-149
U-Bolt to Front Spring Cap	85-120	115-163
U-Bolt to Stabilizer Bar Mounting Bracket — R.H	35-50	48-68
Stabilizer Bar to Mounting Bracket — L.H	35-50	48-68

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SPECIAL SERVICE TOOLS

Number	Description	Application
T80T-3010-A	Ball Joint Set	F-150-350 (4x4) Upper and Lower Ball Joint Removal and Installation
T80T-3010-A1	Part of 4WD Ball Joint Set	—
T80T-3010-A2	Part of 4WD Ball Joint Set	—
T80T-3010-A3	Part of 4WD Ball Joint Set	—
T80T-3010-A4	Part of 4WD Ball Joint Set	—
D79P-3283-A	Tie Rod Adjustment Tool	Universal
T00L-3290-D	Tie Rod End Remover	Universal
T80T-5638-A	Front Suspension Bushing Tool Set	Front Drive Axle Suspension Bushing Removal and Installation

CF3020-2C

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SECTION 14-31 Rear Suspension—Leaf Springs

SUBJECT	PAGE
ADJUSTMENTS	
Vehicle Lean	14-31-3
DESCRIPTION	
Rear Shock Absorber	14-31-1
Rear Suspension	14-31-1
DIAGNOSIS AND TESTING	
Rear Leaf Spring Squeak	14-31-1
REMOVAL AND INSTALLATION	
Rear Shock Absorber—Econoline	14-31-3
Rear Shock Absorber—F-Series Vehicles and Bronco	14-31-4
Rear Spring	14-31-9
E-150	14-31-9
E-250-E-350	14-31-9
F-150—F-250—F-350 (4x2) (4x4), F-Super Duty Chassis Cab, Stripped Chassis, Motor Home Chassis and Bronco	14-31-9
Rear Stabilizer Bar	14-31-10
F-150—F-250—F-350 (4x2) (4x4), F-Super Duty Chassis Cab, Stripped Chassis, Motor Home Chassis and Bronco	14-31-10
SPECIFICATIONS	14-31-19
VEHICLE APPLICATION	14-31-1

VEHICLE APPLICATION

Applies to E-150—E-350, F-150—F-350, F-Super Duty Chassis Cab, Stripped Chassis, Motor Home Chassis and Bronco Vehicles.

DESCRIPTION

Rear Suspension

Semi-elliptic, leaf-type springs are used for the rear axle suspension. The forward end of each spring is attached to a bracket on the frame side member. The rear end of each spring is shackled to a bracket on the frame side member. (Figs. 1 through 11).

Optional auxiliary rear springs are mounted on top of the main spring with free ends. These provide load carrying capacity and stability. Auxiliary springs are standard on all F-350 and all F-Super Duty series vehicles (Figs. 3, 4, 5, 6 and 8).

Rear Shock Absorber

Both the hydraulic shock absorbers and the low pressure gas shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both on compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The low pressure gas shock absorbers are sealed and charged with nitrogen gas to reduce shock absorber fade and improve vehicle ride. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

DIAGNOSIS AND TESTING

Rear Leaf Spring Squeak

To correct a squeaking condition at the rear leaf springs, first determine whether it is the spring loose bolts, or the shackle bushings squeaking. If it is determined to be loose bolts, tighten them. If it is the bushings, replace them. If it is the springs, install spring tip liners to correct the squeak. If the original spring clip is damaged during removal, install a new service spring clip. Also check for metal burrs rubbing between the leaves such as the clip rivet. These burrs should be removed.

Tip Liner Installation

1. Raise the vehicle by the frame so that the rear axle hangs freely.
2. Bend the spring clip to provide clearance between the spring leafs, allowing insertion of the liners. A pry-bar may be used between the leaves to provide additional clearance for insertion of liners.
3. Slide the liner (5586) between the leaves until the liner extends approximately 6.35mm (0.25 inch) beyond the tip of the lower leaf. Do not attempt to install a liner between the lowest primary leaf and the short, 12.70mm (0.50 inch) thick secondary leaf found at the bottom of the leaf stack on some assemblies.
4. Set the rear axle on a stand to load the rear leaf springs placing the leafs in contact with one another at the clip locations.
5. Reinstall production clips or install the replacement service clip.

NOTE: On some of the tip liners, sections of the edge used to center the liner on the spring leaves may need to be trimmed off to accommodate the spring clip.

Service Spring Clip Installation

Refer to Fig. 12.

1. Load the rear leaf springs with the rear of the vehicle supported, either directly by the rear axle or by the tires. The spring leaves should all be in contact with one another at the intended clip location.
2. Remove the damaged clip by prying back the ends of the clip which are folded across the leaf spring until the clip can be freed from the spring. On some clips it will also be necessary to pry the locating pin out of the locating hole. (Locating holes are the holes punched out of the lowest leaf the clip encircles which indicate the proper spring clip location.)

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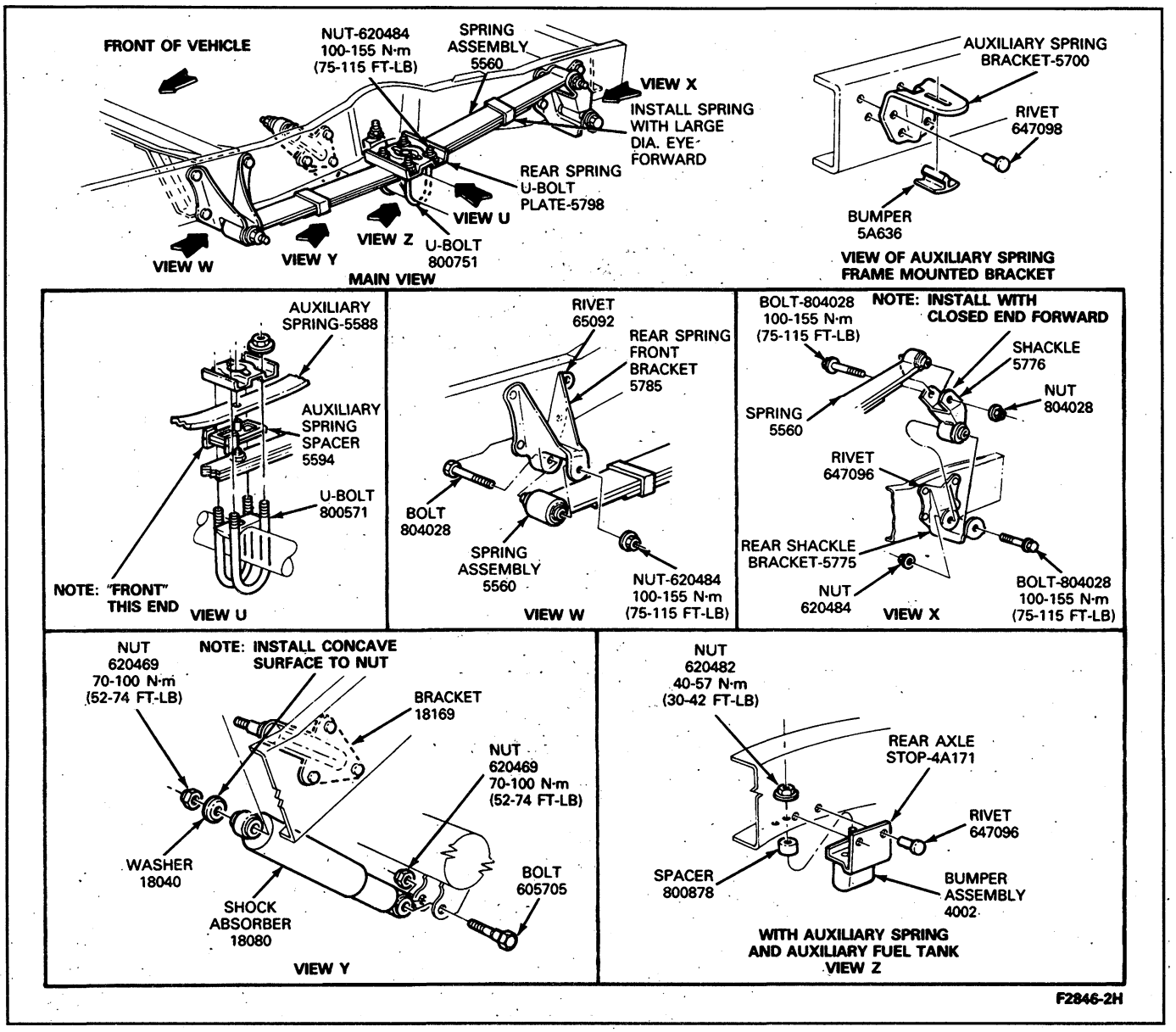


FIG. 1 Rear Spring Installation—F-150 (4x2)

3. Make sure the locating hole is clean and free of debris.
4. Position the lower part of the service clip (5724) across the width of the underside of the spring, such that the hole in the clip lines up with the locating hole in the spring. The legs of the clip lower half should extend down from the bottom of the spring.
5. Insert the drive rivet that comes with the clamp through the hole in the lower part of the service clip into the hole in the spring leaf. The flat face of the rivet flange should rest against the clip lower half.
6. Fully seat the rivet with a hammer. If there is not enough room to hit the rivet directly with a hammer, a punch may be used. The slotted legs of the clip lower half should extend downward, the outer surface of the legs flush with the sides of the leaf spring.
7. Place the rubber service clip liner across the top of the leaf spring, directly above where the bottom half of the clip attaches to the spring, with the flat surface against the leaf and the clip locating edges extending upward.
8. Place the clip upper half between the locating edges of the rubber liner and align the threaded holes in the clip upper half with the slots in the clip lower half.
9. Hand start the two screws through the clip lower half slot into the clip upper half threaded hole. The screw heads will be located under the spring, ultimately pressing against the inner surface of the clip lower half.
10. Squeeze the clip to the spring with one hand while tightening the screws. Tighten to 21-27 N·m (15-20 ft-lbs).

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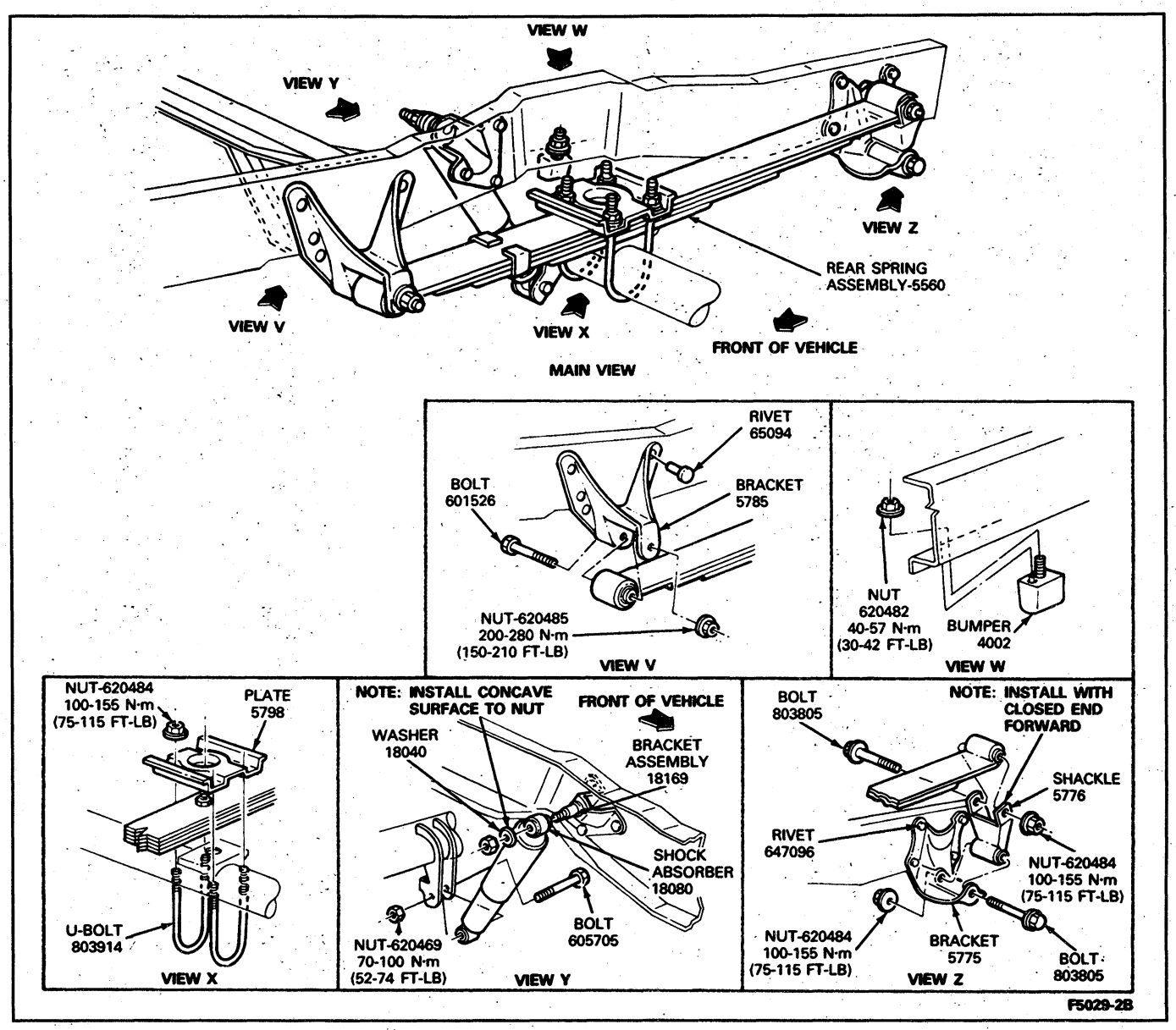


FIG. 2 Rear Spring Installation-Conventional—F-250—F-350 (4x2) Regular Cab and Super Cab

ADJUSTMENTS

Vehicle Lean

F-150—F-250—F-350 (4x2) (4x4), F-Super Duty and Bronco

A side-to-side lean at the rear of the vehicle can be adjusted by approximately 9.52mm (3/8 inch) by installing a shim between the rear spring and axle on the low side of the vehicle. A "low at the rear" vehicle can be raised approximately 9.52mm (3/8 inch) by installation of one shim on each side. If side to side lean at rear is greater than 12-70mm (1/2 inch), switch the rear springs side to side. Use the following procedure to install the shim (D7TA-5742-AA):

1. Raise the vehicle frame until the weight is off the rear springs but with the tires still touching the floor.
2. Loosen the spring U-bolts to allow the axle to separate from the spring approximately 12.70mm (1/2 inch).
3. Position the shim (D7TA-5742-AA) between the spring and axle with the long edge of the shim parallel to the side of the spring and the spring tie bolt head through the hole in the shim. On 4x4 vehicles, position the shim between the rear spring and axle spacer. Tape may be used to hold the shim in position.
4. Assure that the spring leaves are properly aligned and the spring U-bolts contact the edges of the spring assembly or axle seat.
5. Tighten the spring U-bolt sufficiently to assure that the spring tie bolt head that extends through the shim enters the hole in the axle seat.

REMOVAL AND INSTALLATION

Rear Shock Absorber—Econoline

Refer to Figs. 10 and 11.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kpa (135 psi).

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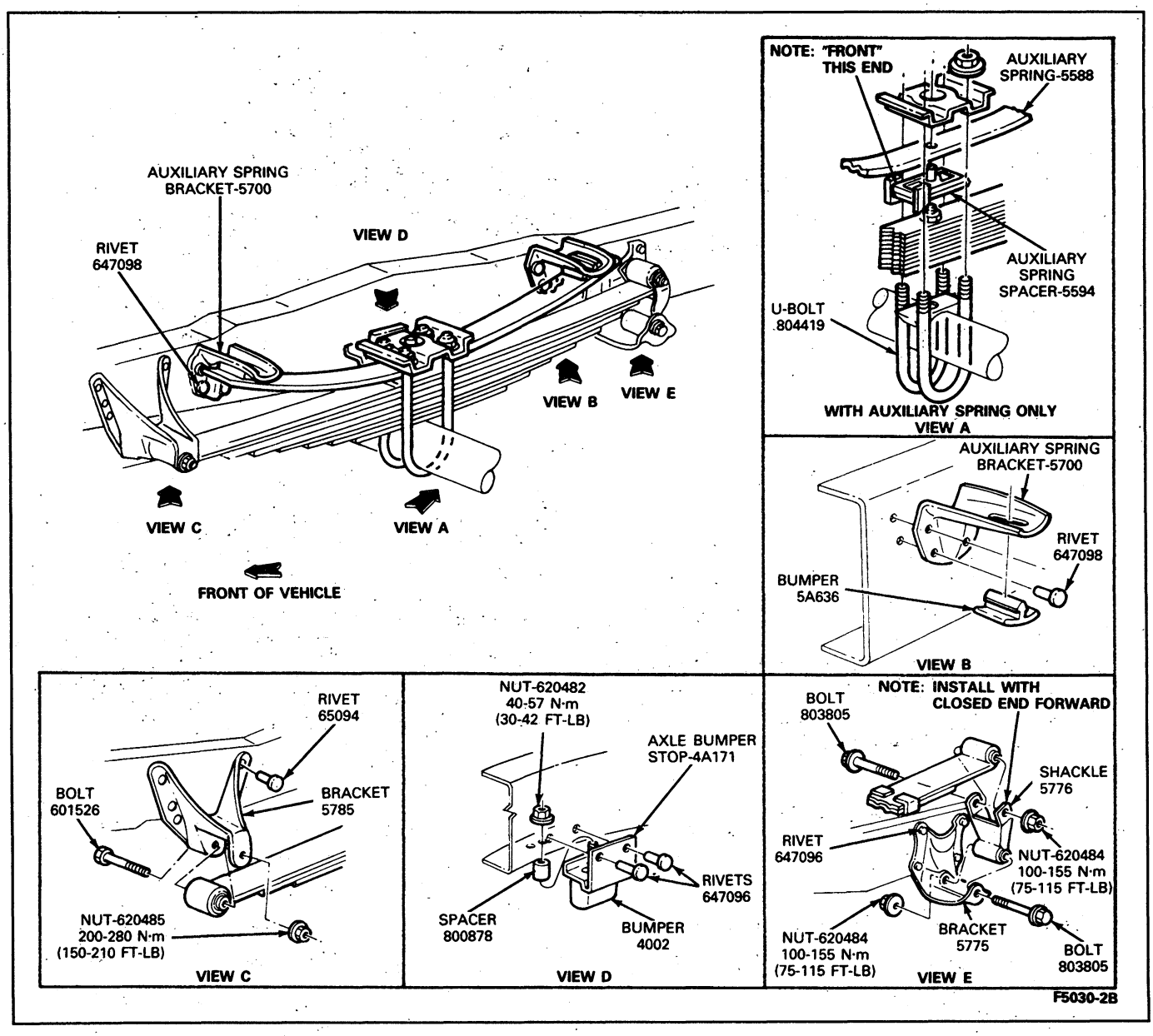


FIG. 3 Rear Spring Installation with Auxiliary Spring—F-250—F-350 (4x2)—Regular and Super Cab

Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Raise the vehicle on a hoist.
2. Remove the shock absorber lower attaching nut and bolt, and swing the lower end free of the mounting bracket on the axle housing.
3. Remove the attaching nut from the upper mounting stud, and remove the shock absorber.

Installation

1. Position the replacement shock absorber with rubber bushings and steel washers to the upper mounting bolt.
2. Swing the lower end of the shock absorber into the mounting bracket on the axle housing. Install the mounting bolt, and self-locking nut. Tighten the nut to specifications listed at the end of this Section.
3. Install the washer and self-locking nut on the upper mounting bolt. Tighten the nut to specifications listed at the end of this Section.

Rear Shock Absorber—F-Series Vehicles and Bronco

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kpa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

Refer to Fig. 13.

Removal

1. Raise the vehicle on a hoist.
2. Remove the shock absorber lower attaching nut and bolt, and swing the lower end free of the mounting bracket on the axle housing.
3. Remove the nut and bolt from the upper shock absorber mount.

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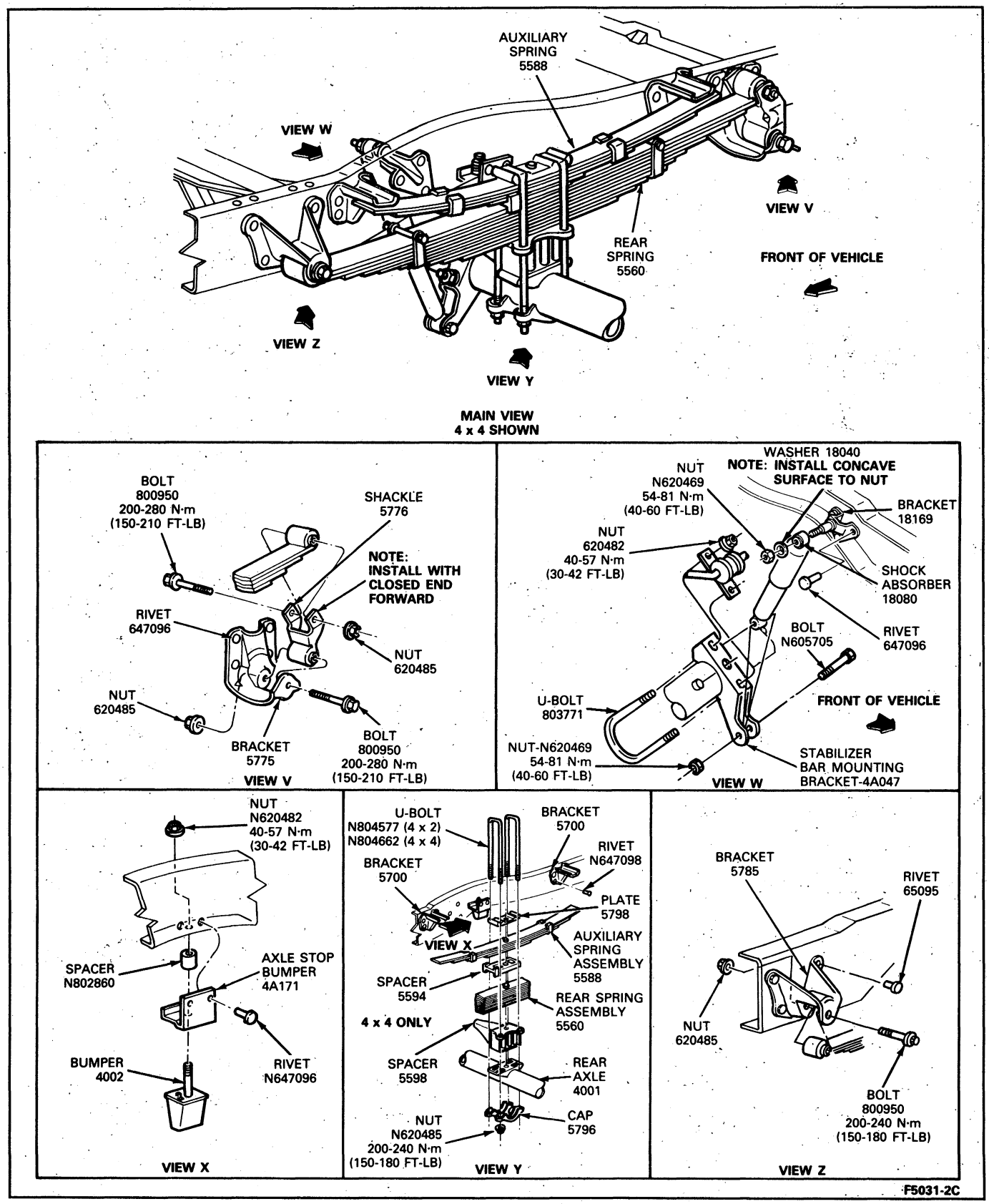


FIG. 4 Rear Spring Installation—F-350 (4x2 and 4x4) Chassis Cab with Ford Axles

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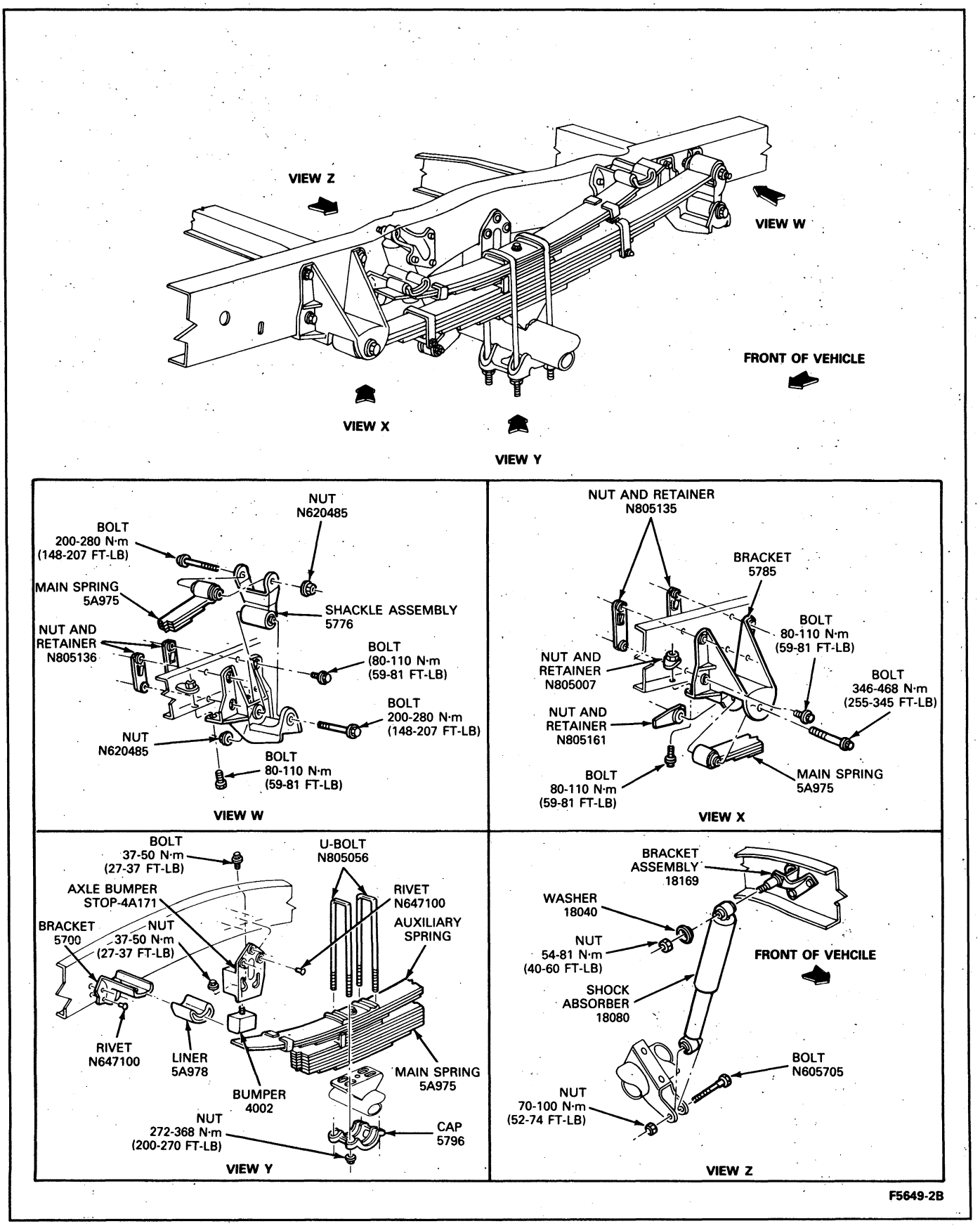


FIG. 5 Rear Spring Installation—F-Super Duty

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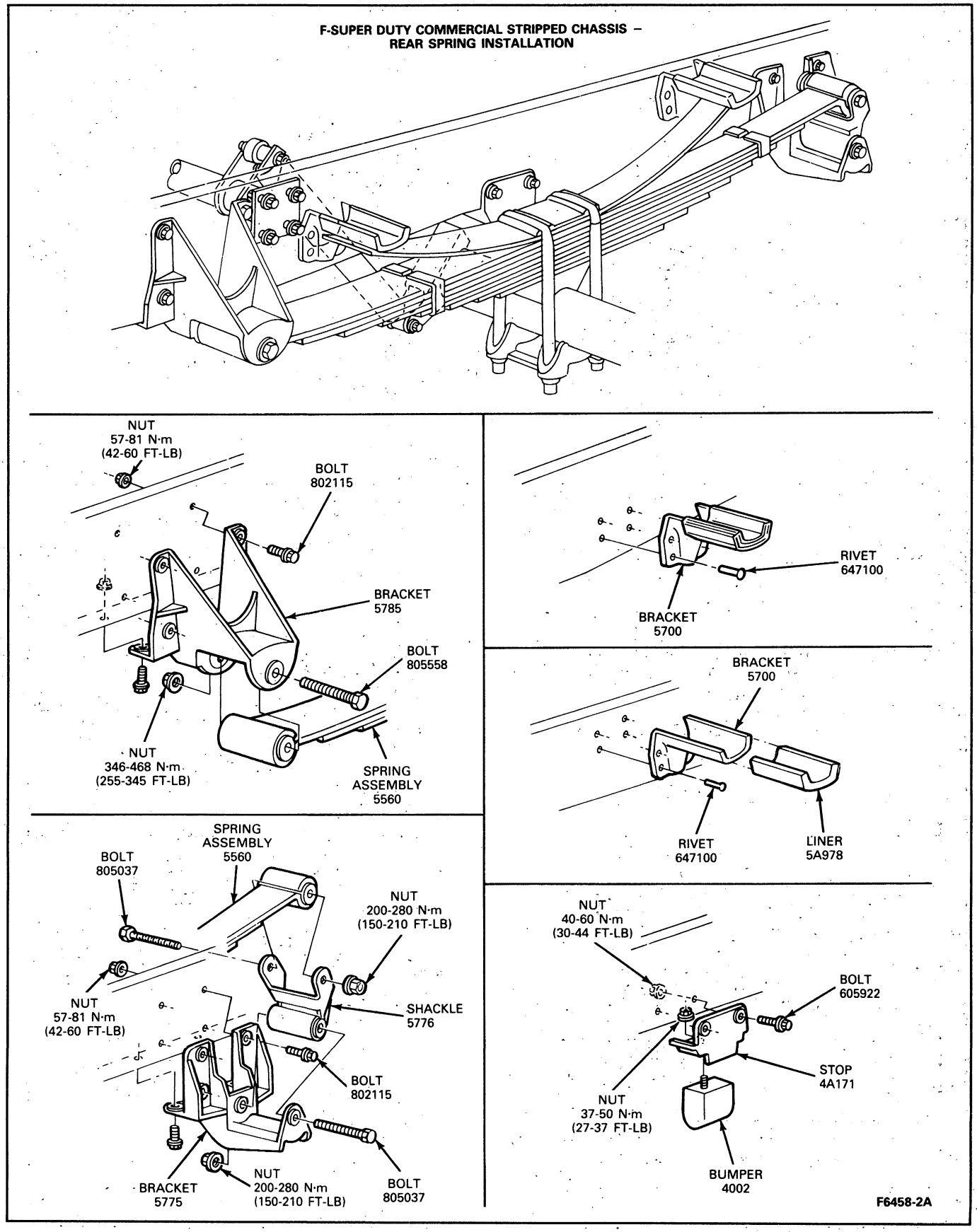


FIG. 6 Rear Spring Installation—F-Super Duty Stripped Chassis and Motor Home Chassis

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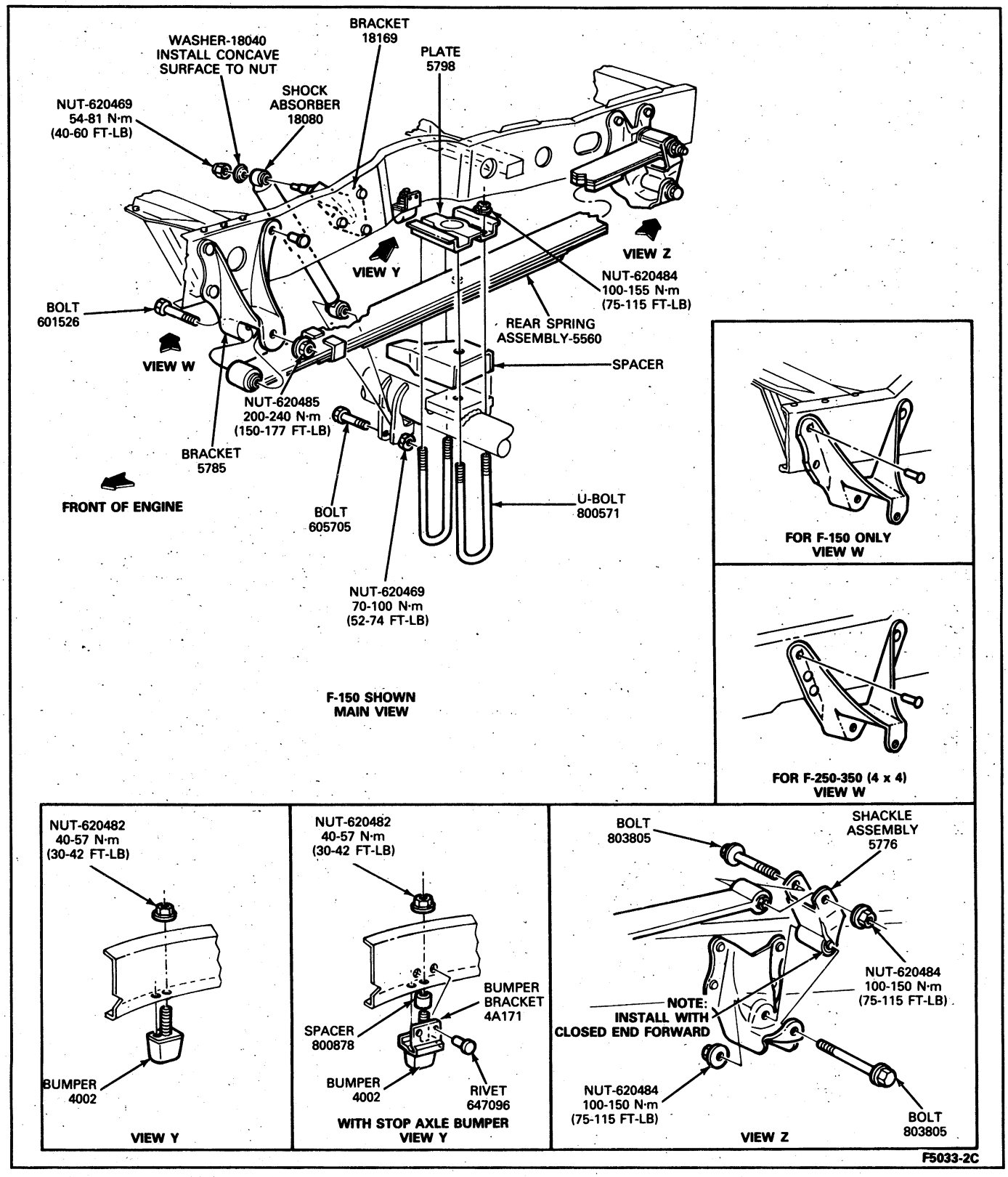


FIG. 7 Rear Spring Installation—F-150—F-350 (4x4)

Installation

1. Position the replacement shock absorber to the upper mount and install the nut, bolt and washers.
2. Swing the lower end of the shock absorber into the mounting bracket on the axle housing. Install the mounting bolt, nut and washers. Tighten the nut to specifications listed at the end of this Section.

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3. Tighten the upper nut and bolt to the specifications listed at the end of this section.

Rear Spring

F-150—F-250—F-350 (4x2) (4x4), F-Super Duty Chassis Cab, Stripped Chassis, Motor Home Chassis and Bronco

Refer to Figs. 1-11.

Removal

1. Raise the vehicle frame, until the weight is off the rear spring, with the tires still touching the floor.
2. Remove the nuts from the spring U-bolts and drive the U-bolts from the U-bolt plate. If so equipped, remove the auxiliary spring and spacer.
3. Remove the spring-to-bracket nut and bolt at the front of the spring.
4. Remove the shackle upper and lower nuts and bolts at the rear of the spring. Remove the spring and shackle assembly from the rear shackle bracket.

Installation

1. Position the spring in the shackle, and install the upper shackle-to-spring bolt and nut with the bolt head facing outboard.
2. Position the front end of the spring in the bracket and install the bolt and nut.
3. Position the shackle in the rear bracket and install the bolt and nut.
4. Position the spring on top of the axle with the spring tie bolt centered in the hole provided in the seat. If so equipped, install the auxiliary spring and spacer.
5. Install the spring U-bolts, U-bolt plate and nuts.
6. Lower the vehicle to the floor. Tighten the spring U-bolt nuts to specifications as listed at the end of this Section. Tighten the front spring bolt and nut and the rear shackle bolts and nuts to specifications as listed at the end of this Section.

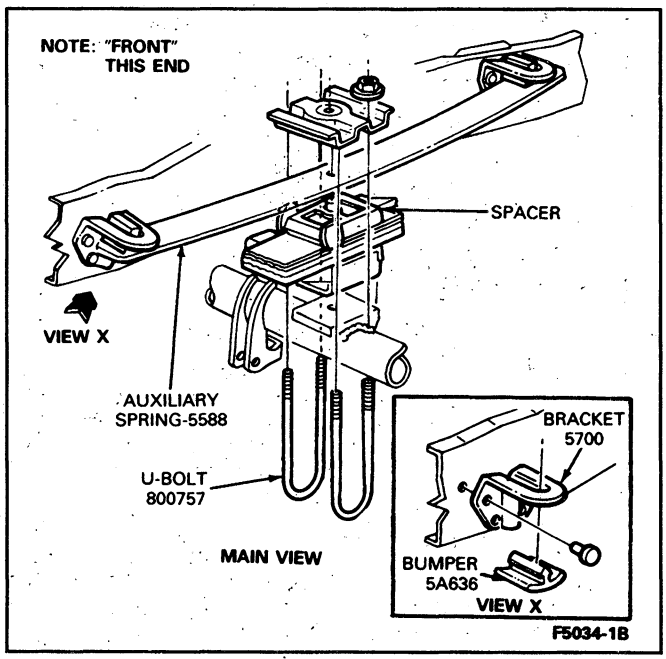


FIG. 8 Rear Spring Installation with Auxiliary Spring—F-150—F-350 (4x4)

Rear Spring

E-150

Refer to Fig. 10.

Removal

1. Raise the rear end of the vehicle and support the chassis with safety stands. Support the rear axle with a floor jack or hoist.
2. Disconnect the lower end of the shock absorber from the bracket on the axle housing.
3. Remove the two U-bolts and plate.
4. Lower the axle and remove the upper and lower rear shackle bolts.
5. Pull the rear shackle assembly from the bracket and spring.
6. Remove the nut and mounting bolt that secures the front end of the spring. Remove the spring assembly from the front shackle bracket.

Installation

1. Assemble the front eye of the spring to the front bracket with the front mounting bolt and nut. Do not tighten the nut.
2. Mount the rear end of the spring with the upper bolt of the rear shackle assembly passing through the eye of the spring. Insert the lower bolt through the rear spring, shackle bracket.
3. Assemble the spring center bolt in the pilot hole in the axle and install the plate. Install the U- bolts through the plate. Do not tighten the attaching nuts at this time.
4. Raise the axle with a floor jack or hoist until the vehicle is free of the stands. Connect the lower end of the shock absorber to the bracket on the axle housing.
5. Tighten the spring front mounting bolt and nut, the rear shackle nuts and the U-bolt nuts. Tighten all bolts and nuts to specifications as listed at the end of this Section.
6. Remove the safety stands and lower the vehicle.

Rear Spring

E-250-E-350

Refer to Fig. 11.

Removal

1. Raise the rear end of the vehicle and support the chassis with safety stands. Support the rear axle with a floor jack or hoist.
2. Disconnect the lower end of the shock absorber from the bracket on the axle housing (Fig. 10).
3. Remove the two spring U-bolts and the U-bolt plate.
4. Lower the axle and remove the spring front bolt from the hanger.
5. Remove the two attaching bolts from the rear of the spring. Remove the spring and the shackle.

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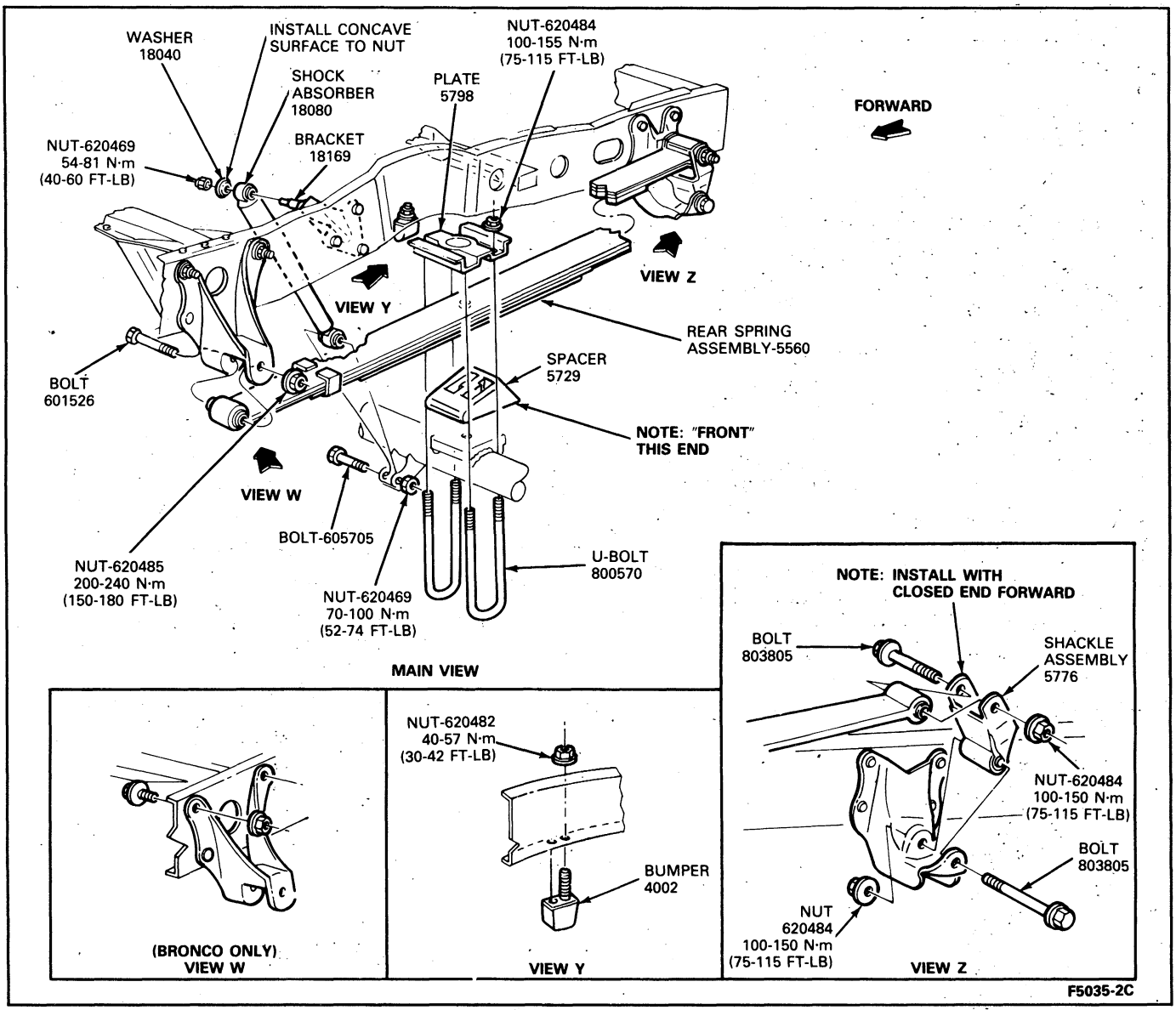


FIG. 9 Rear Spring Installation—Bronco

Installation

1. Assemble the upper end of the shackle to the spring with the attaching bolt as shown in Fig. 10.
2. Connect the front of the spring to the front bracket with the attaching bolt.
3. Assemble the spring and shackle to the rear bracket with the attaching bolt.
4. Place the U-bolt plate over the nut of the center bolt.
5. Raise the axle with a jack. Install the center bolt head through the pilot hole in the pad on the axle housing.
6. Install the spring U-bolts and attaching nuts. Tighten the nuts snugly.
7. Connect the lower end of the shock absorber to the lower bracket.
8. Tighten the spring front mounting bolt and nut, the rear shackle nuts and spring U-bolt nuts. Tighten to specifications as listed at the end of this Section.
9. Remove the safety stands and lower the vehicle.

Rear Stabilizer Bar

F-150—F-250—F-350 (4x2) (4x4), F-Super Duty Chassis Cab, Stripped Chassis, Motor Home Chassis and Bronco

Refer to Figs. 15 and 18.

Removal

1. Remove nut from lower end of stabilizer bar link.
2. Remove outer washer and insulator. Disconnect stabilizer bar from link.
3. Remove inner insulators and washers. Disconnect link from frame by removing nuts and bolts.
4. Remove nuts which fasten U-bolts, brackets and retainers.

Installation

1. Install outer insulator and washer on link. Install and tighten nuts to specification.

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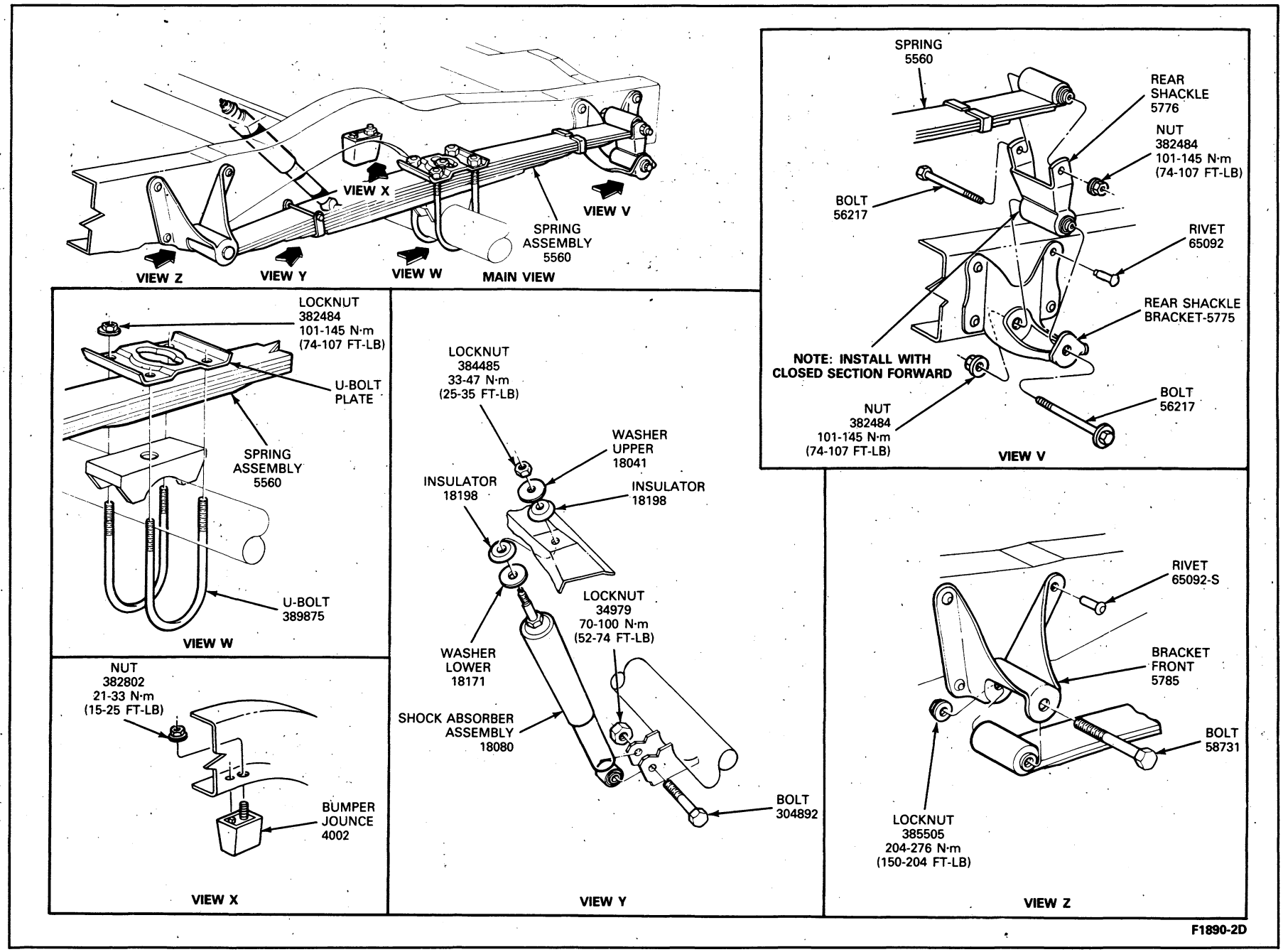


FIG. 10 Rear Spring Installation—E-150

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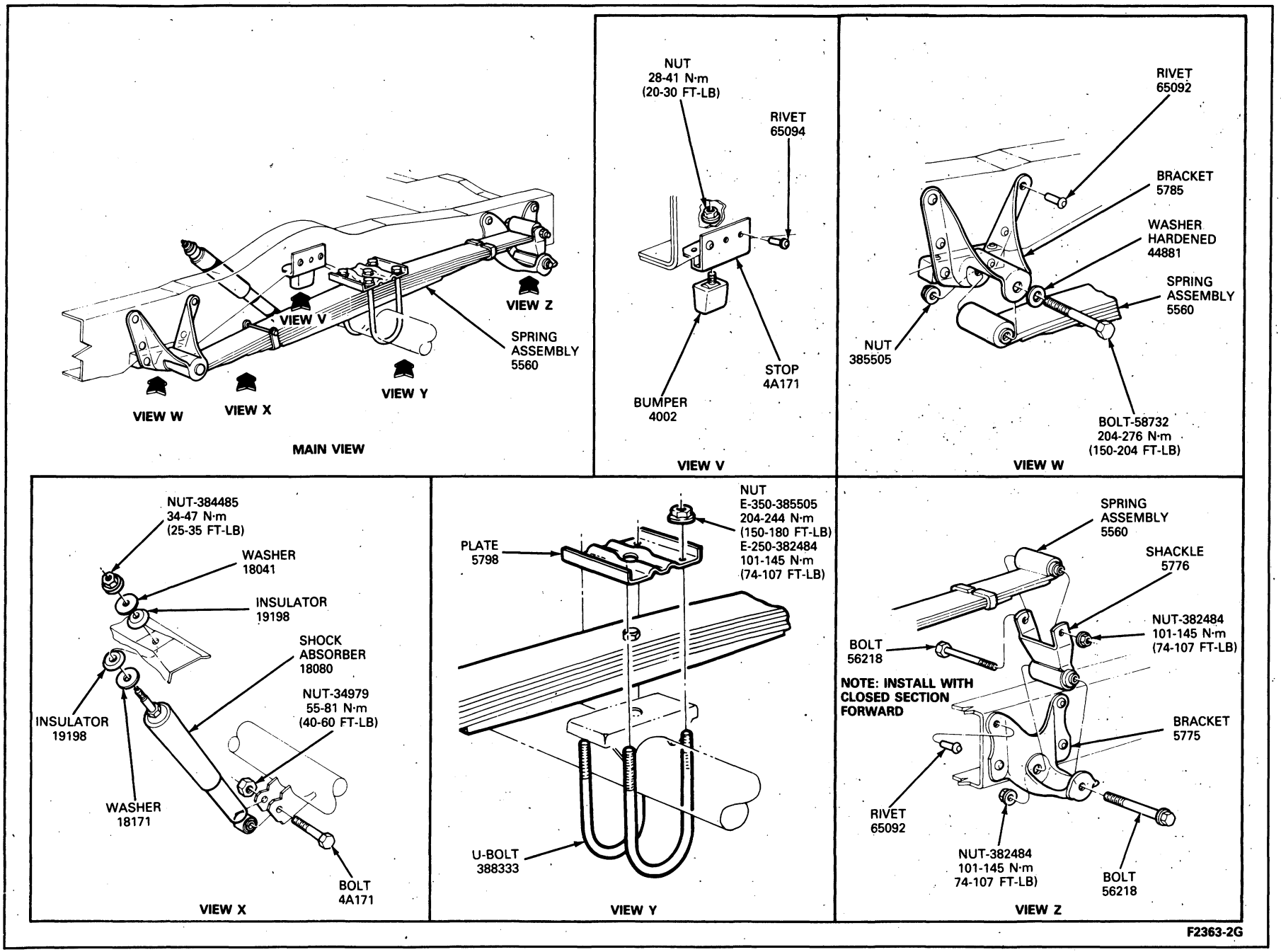


FIG. 11 Rear Spring Installation—E-250—E-350

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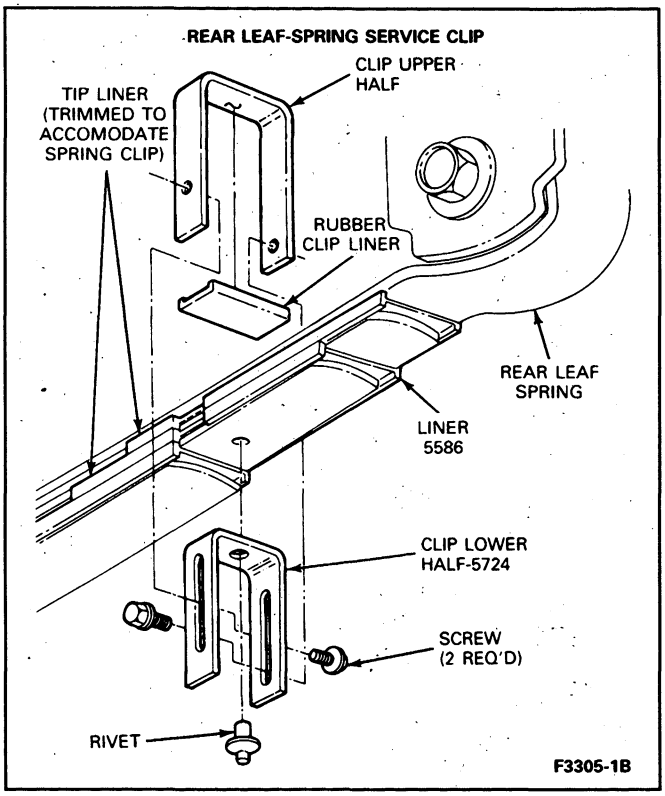


FIG. 12 Service Spring Clip Installation

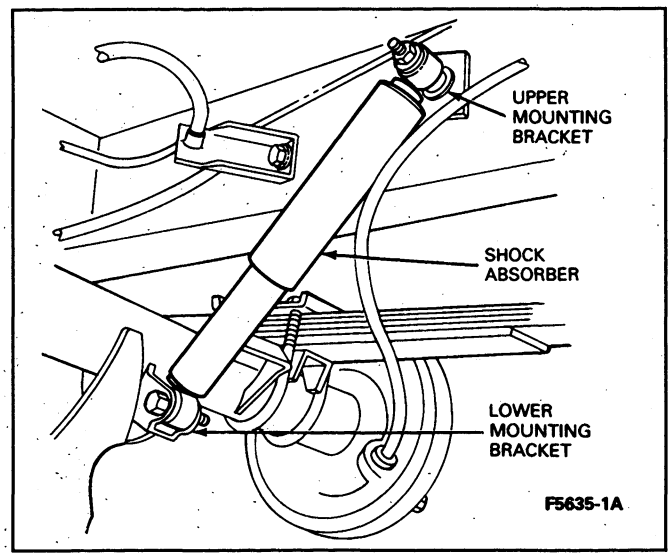


FIG. 13 Rear Shock Absorber Installed (F-Series Only)—Typical

2. Position U-bolts, brackets and retainers to frame. Install and tighten nuts to specification.
3. Install inner insulator and washer on link. Connect link to stabilizer bar.
4. Install outer insulator and washer on link. Install and tighten nuts to specification.

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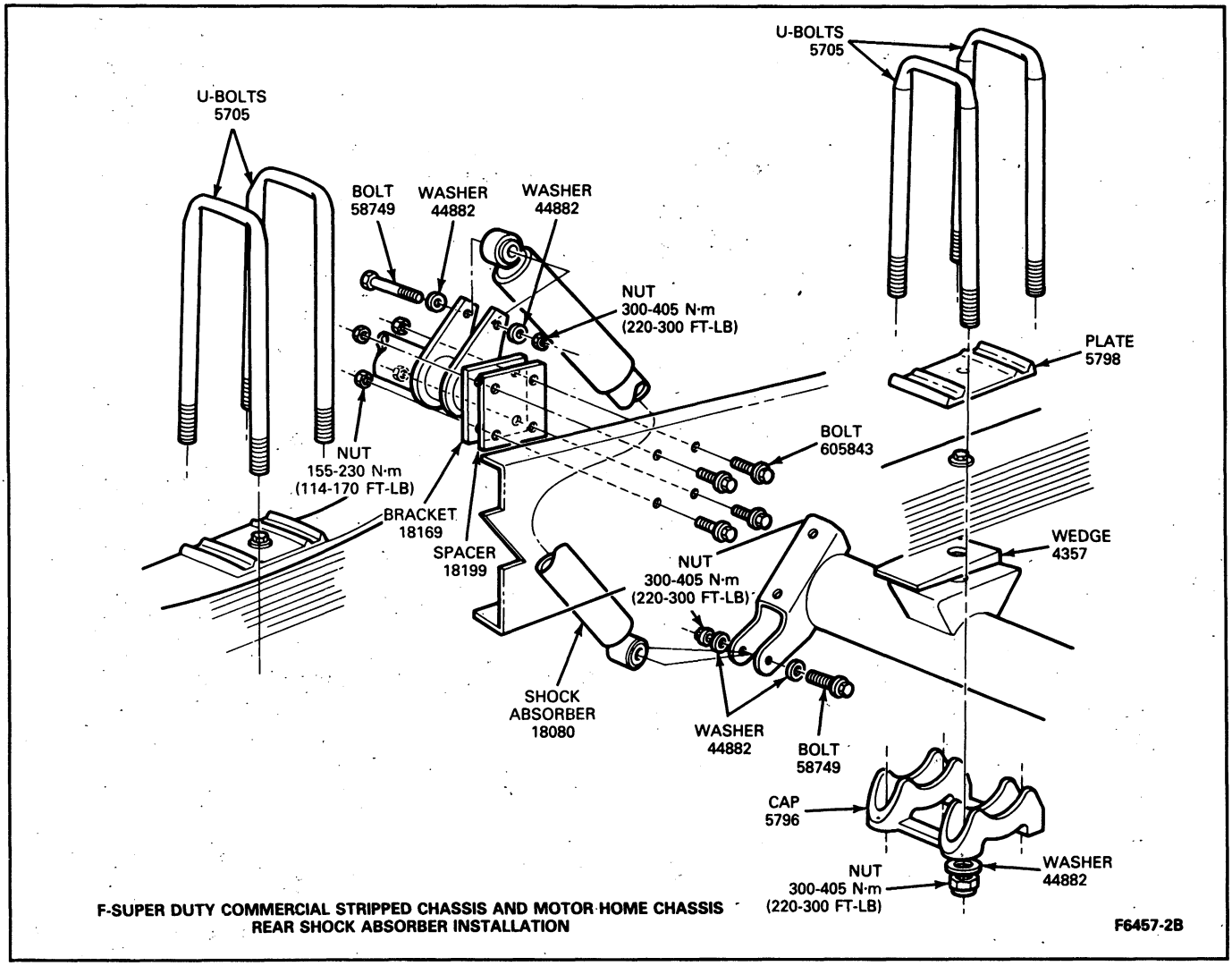


FIG. 14 Rear Shock Absorber Installation—F-Super Duty Stripped Chassis and Motor Home Chassis Vehicles

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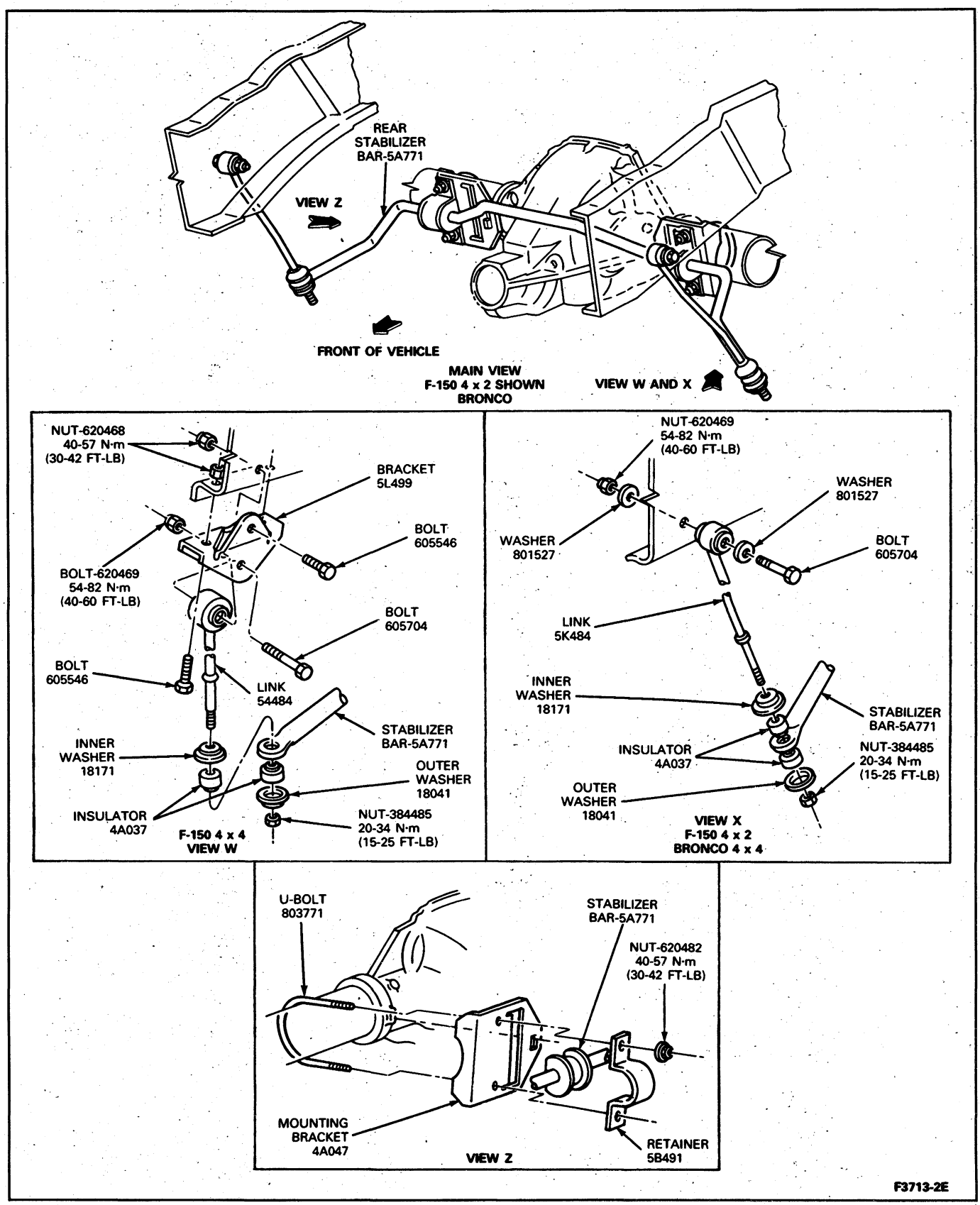


FIG. 15 Rear Stabilizer Bar Installation—Bronco, F-150 (4x2), (4x4)

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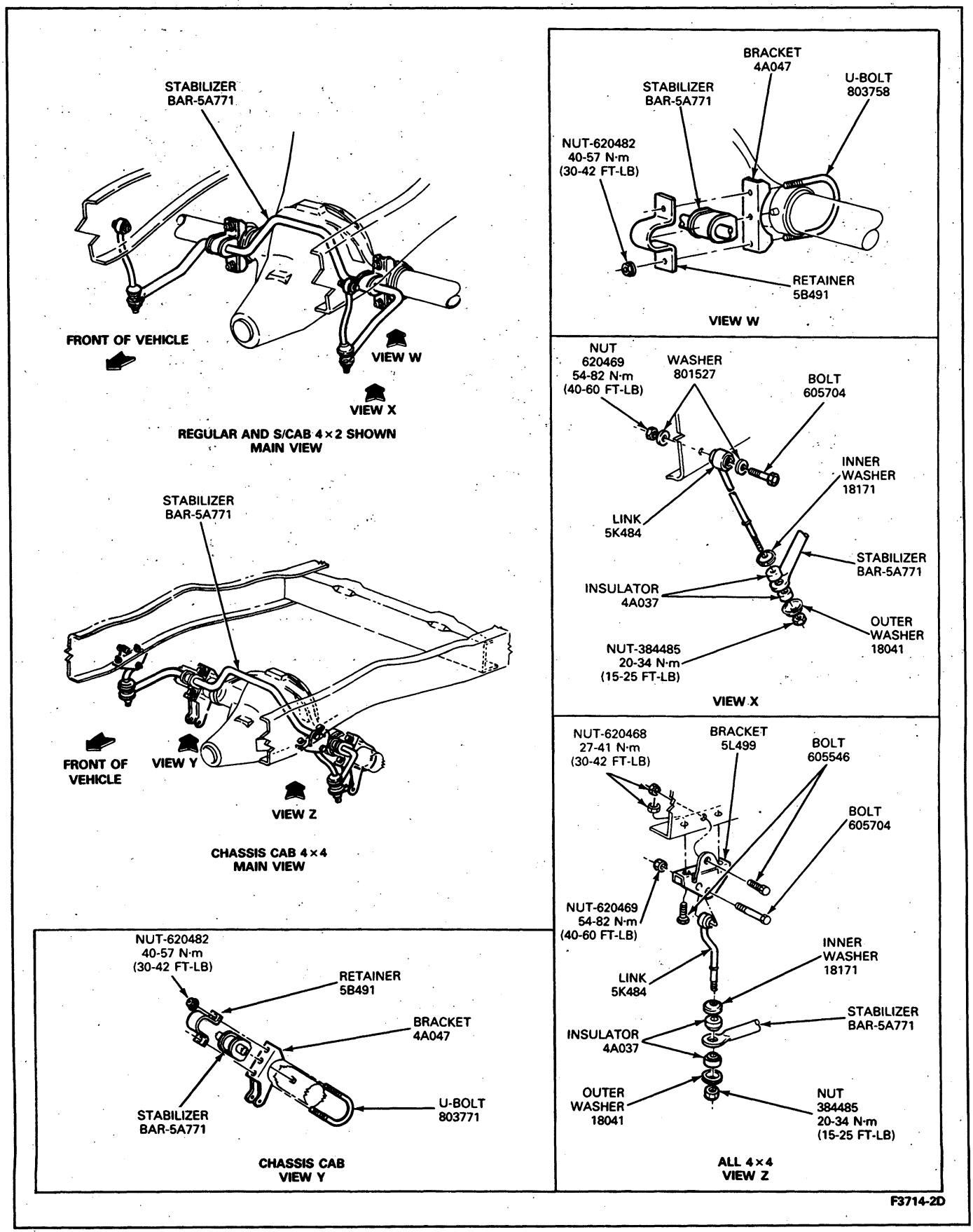


FIG. 16 Rear Stabilizer Bar Installation—F-250—F-350 with Ford Rear Axle

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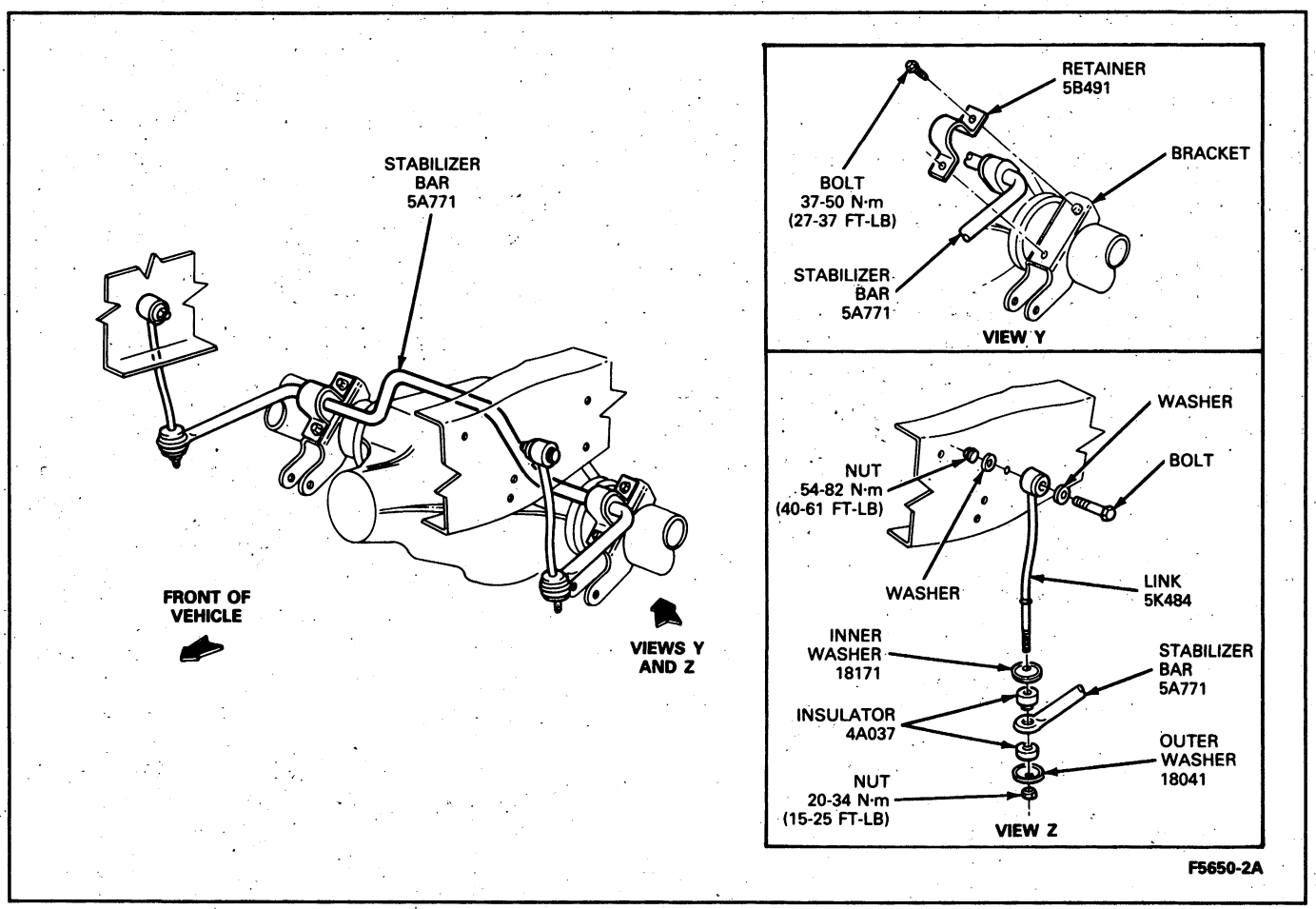


FIG. 17 Rear Stabilizer Bar Installation—F-Super Duty

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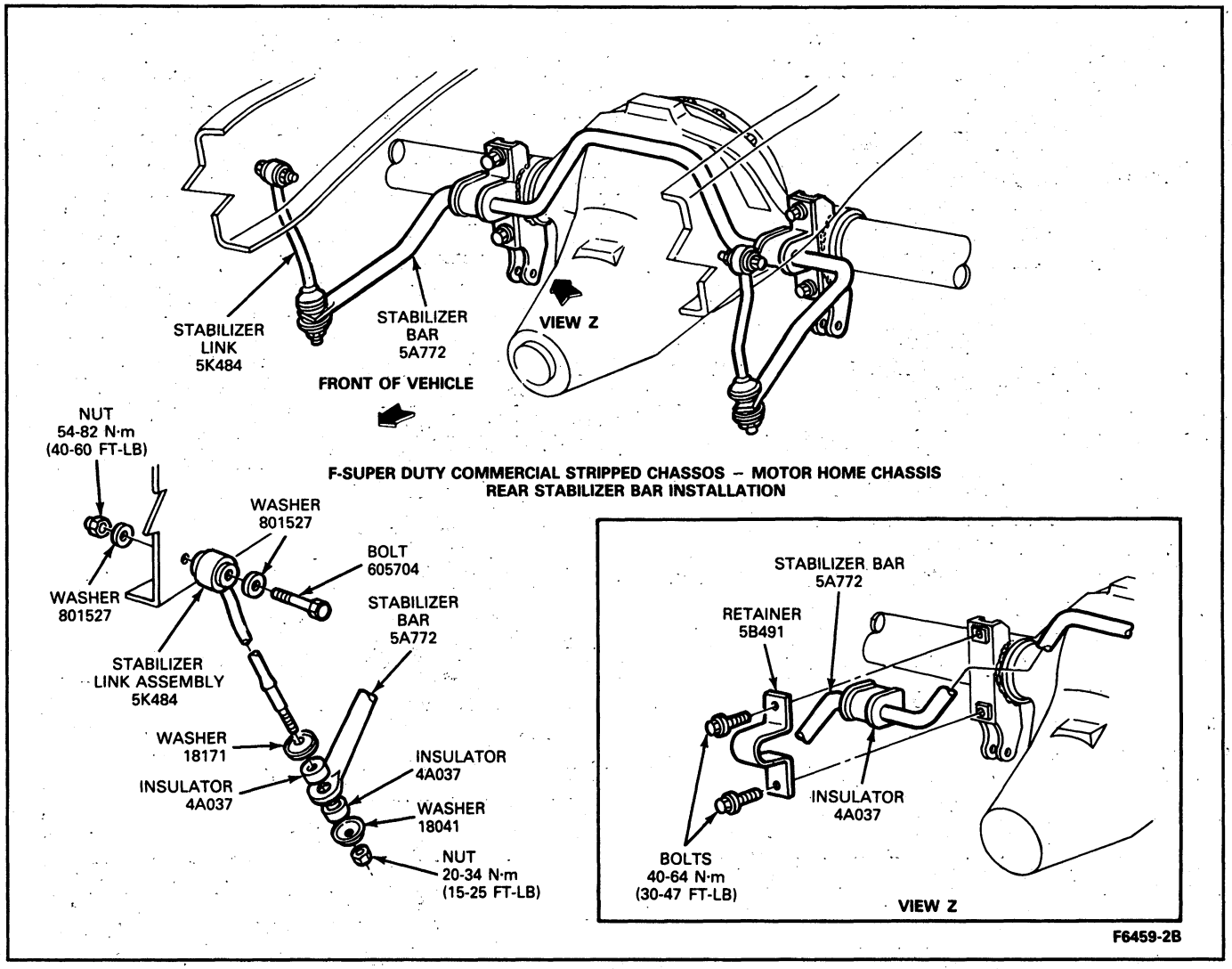


FIG. 18 Rear Stabilizer Bar Installation—F-Super Duty Stripped Chassis and Motor Home Chassis

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SPECIFICATIONS

TORQUE SPECIFICATIONS — F-150 — F-250 — F-350 (4x2), (4x4), F-SUPER DUTY AND BRONCO

Description	Application	Torque Range	
		N·m	Ft-Lbs
Jounce Bumper to Frame Nut	All	40-57	30-42
Leaf Spring to Axle U-Bolt Nut	F-150 — F-250 (under 8500 GVW)	100-155	75-115
	F-250 — F-350 (4x2) Chassis Cab (over 8500 GVW)	200-280	150-210
	F-Super Duty	272-368	200-270
Leaf Spring to Front Bracket Nut and Bolt	F-250-F-350 (4x2) Bronco	200-280	150-210
	F-150 (4x2)	100-155	75-115
	F-150-F-250-F350 (4x4)	200-240	150-177
	F-Super Duty	346-468	255-345
Leaf Spring to Rear Shackle Nut and Bolt	All except F-250 — F-350 (4x2) Chassis Cab	100-150	75-115
	F-250 — F-350 (4x2) Chassis Cab and F-Super Duty	200-280	150-210
Rear Shackle to Frame Nut and Bolt	All except F-250 — F-350 (4x2) Chassis Cab	100-150	75-115
	F-250 — F-350 (4x2) Chassis Cab and F-Super Duty	200-280	150-210
Shock Absorber (Lower Mount) to Axle Nut and Bolt	All	70-100	52-74
Shock Absorber (Upper Mount) to Frame Nut	All	54-81	40-60
Shock Absorber/Stabilizer Bar Bracket to Axle Nut	F-250 — F-350 (4x2) Chassis Cab	40-57	30-42
Stabilizer Bar to Axle Nut	All	40-57	30-42
Stabilizer Bar to Axle Bolt	F-Super Duty	37-50	27-37
Stabilizer Link Bracket to Frame Nut and Bolt	All 4x4 Vehicles	40-57	30-42
Stabilizer Link to Bracket Nut and Bolt	All 4x4 Vehicles	54-82	40-60
Stabilizer Link to Frame Nut and Bolt	All 4x2 Vehicles	54-82	40-60
Stabilizer Link to Stabilizer Bar Nut	All	20-34	15-25
TORQUE SPECIFICATIONS — E-150 — E-250 — E-350			
Jounce Bumper to Frame Nut	E-150	21-33	15-25
	E-250 — E-350	28-41	20-30
Leaf Spring to Axle U-Bolt Nut	E-150	101-145	74-107
	E-250 (Light Duty — 4050)	101-145	74-107
	E-250 — E-350	204-244	150-180
Leaf Spring to Front Bracket Nut and Bolt	E-150 — E-250 — E-350	204-276	150-204
Leaf Spring to Rear Shackle Nut and Bolt	E-150 — E-250 — E-350	101-145	74-107
Rear Shackle to Frame Nut and Bolt	E-150 — E-250 — E-350	101-145	74-107
Shock Absorber (Lower Mount) to Axle Nut and Bolt	E-150 — E-250 — E-350	70-100	52-74
Shock Absorber (Upper Mount) to Frame Nut	E-150 — E-250 — E-350	33-47	25-35

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TORQUE SPECIFICATIONS — F-SUPER DUTY COMMERCIAL STRIPPED CHASSIS AND MOTOR HOME CHASSIS

Description	Torque Range	
	N·m	Ft-Lb
Jounce Bumper to Frame Nut	37-50	27-37
Leaf Spring to Axle U-Bolt Nut	300-405	220-300
Leaf Spring to Front Bracket Nut and Bolt	346-468	255-345
Leaf Spring to Rear Shackle Nut and Bolt	200-280	150-210
Rear Shackle to Frame Mounted Bracket Nut and Bolt	200-280	150-210
Shock Absorber (Lower Mount) to Axle Nut and Bolt	300-405	220-300
Shock Absorber (Upper Mount) to Bracket Nut and Bolt	300-405	220-300
Shock Absorber Upper Bracket to Frame Nuts and Bolts	155-230	114-170
Stabilizer Bar to Axle Bolt	40-64	30-47
Stabilizer Link to Frame Nut and Bolt	54-82	40-60
Stabilizer Link to Stabilizer Bar Nut	20-34	15-25

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GENERAL DRIVING AXLES AND DRIVESHAFTS

GROUP 15

(4000)

SECTION TITLE	PAGE
DRIVESHAFT—DOUBLE CARDAN-TYPE U-JOINT	15-66-1
DRIVESHAFT—SINGLE TYPE U-JOINT	15-61-1
FRONT DRIVE AXLES—DANA MODEL 44 AND 50	15-34-1
FRONT DRIVESHAFT	15-67-1
FRONT DRIVING AXLE—DANA MODEL 60 MONOBEAM	15-32-1
GENERAL DRIVESHAFT SERVICE	15-60-1
GENERAL DRIVING AXLE SERVICE	15-01-1
INTEGRAL CARRIER AXLE—FORD 10.25 INCH RING GEAR	15-09-1
INTEGRAL CARRIER AXLE—8.8 INCH RING GEAR	15-08-1
INTEGRAL CARRIER REAR AXLE—DANA	15-05-1
LIMITED-SLIP DIFFERENTIAL—DANA	15-42-1
LIMITED-SLIP DIFFERENTIAL—FORD—10.25 INCH RING GEAR	15-43-1
TRACTION-LOK DIFFERENTIAL—FORD 8.8 INCH RING GEAR	15-41-1

SECTION 15-01 General Driving Axle Service

SUBJECT	PAGE
ADJUSTMENTS	
Axle Adjustments	15-01-4
Pinion and Ring Gear Adjustments (All Except Dana)	15-01-4
Rear Axle Circular Flange Runout Check-8.8 inch Ring Gear—E-Series and (F-150/Bronco in Later Production)	15-01-11
Rear Axle Companion Flange Runout Check—F-Series	15-01-9
Rear Axle Lubrication	15-01-4
Rear Wheel Bearing and Seal Removal and Installation	15-01-4
Ring Gear Replacement Dana Axles	15-01-4
Shim Selection	15-01-4
CLEANING AND INSPECTION	
Inspection After Carrier Disassembly	15-01-12
Inspection Before Carrier Disassembly	15-01-11
DIAGNOSIS AND TESTING	
Axle Testing	15-01-2
Diagnosis Guides	15-01-4
Limited-Slip Differential Operation Check	15-01-3
Noise Acceptability	15-01-2
Rear Antilock Braking System	15-01-2
Total Axle Backlash Check	15-01-3
SPECIFICATIONS	15-01-14
VEHICLE APPLICATION	15-01-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 (4x2, 4x4) Bronco and F-Super Duty Series Vehicles.

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DIAGNOSIS AND TESTING

Axle Testing

Certain rear axle and driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. For this reason, be sure that the cause of the trouble is in the rear axle before adjusting, repairing, or replacing any of its parts. See Group 18, Noise Vibration and Harshness.

Certain trouble symptoms may be caused by limited-slip differentials. Check the vehicle certification and axle ratio tag to determine the type of differential.

Location of the axle identification code on the rating plate is shown in Figs. 1 and 2. Refer to Section 10-00 for a complete listing of the codes.

Ford Design Axles

The plant code on the axle identification tag is to be used as the official service identifier (Fig. 3).

The Plant Code for a particular axle assembly will not be duplicated. In addition, the Plant Code will not change as long as that particular axle assembly never undergoes an external design change. If, however, an internal design change takes place during the production life of the axle and that internal change affects service parts interchangeability, a dash and numerical suffix will be added to the Plant Code (Fig. 4).

Note that Plant Codes in Figs. 3 and 4 are identical except Fig. 3 shows a numeric. This means that AS AN ASSEMBLY both axles are interchangeable; however, internally they are different. Therefore, each would require different internal service parts at service time.

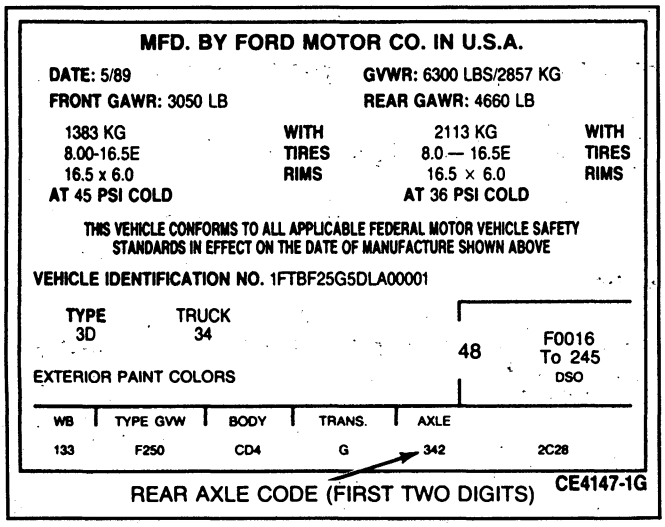


FIG. 1 Truck Safety Compliance Certification Label—Rear Axle Code Location

Dana Design Axles

Rear axles have a metal tag secured under adjacent cover bolt heads listing Ford and Dana part numbers and the ratio. Front drive axles have a similar tag.

Noise Acceptability

A gear driven unit especially a truck drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions, as on a newly paved blacktop road for example. The slight noise is in no way detrimental to operation of the rear axle and must be considered normal.

Rear Antilock Braking System

F-150 through F-350 series and Bronco vehicles use the Rear Antilock Braking System (RABS). Axles in vehicles equipped with the RABS contain a sensor and excitor ring mounted in the carrier. For a detailed description of the RABS see Section 12-31 in this Manual. The system features a multi-tooth excitor ring that is pressed on the differential case behind the ring gear. If the excitor ring is removed, it must be discarded and replaced with a new one. The excitor ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space

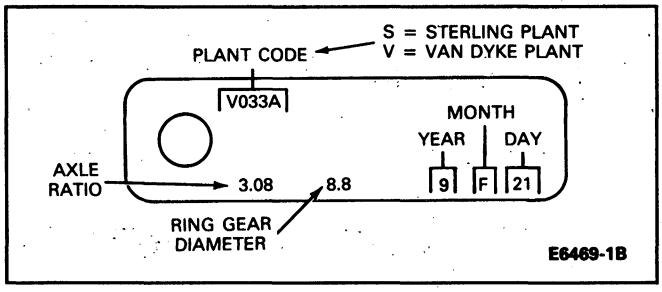


FIG. 3 Rear Driving Axle Model Identification Tag

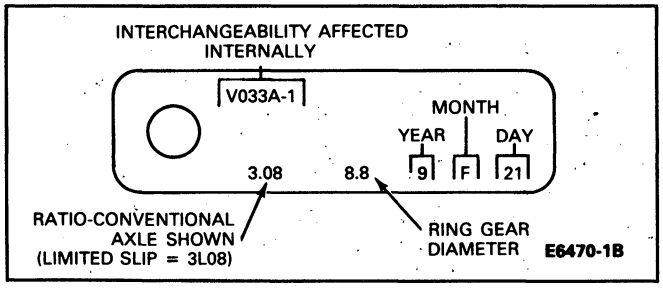


FIG. 4 Internal Change Identification Tag

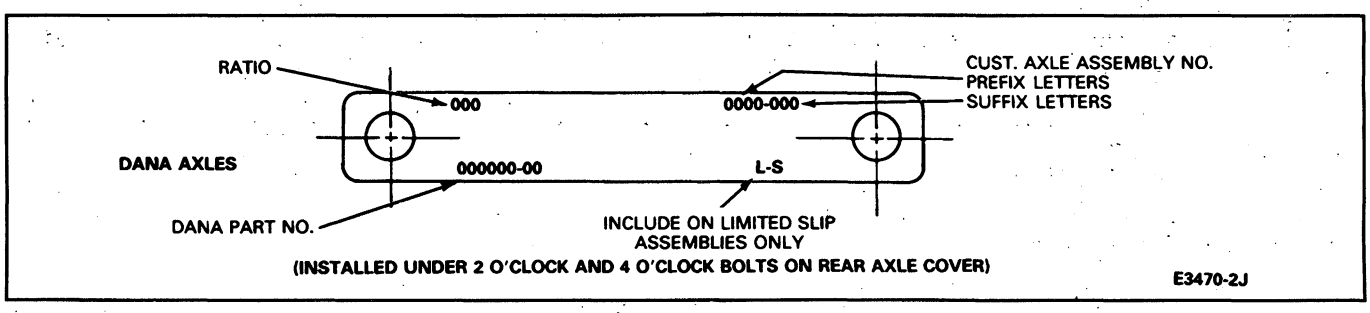


FIG. 2 Axle Identification Tags—Dana

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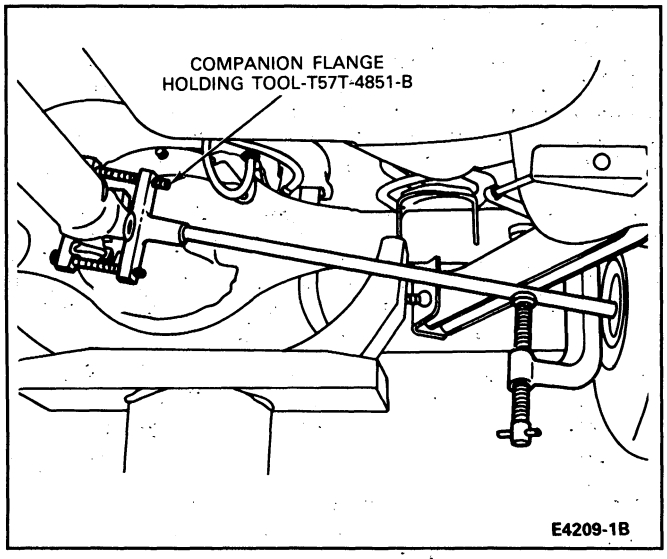


FIG. 5 Lock Axle for Total Backlash Check—Ford F-Series Axles

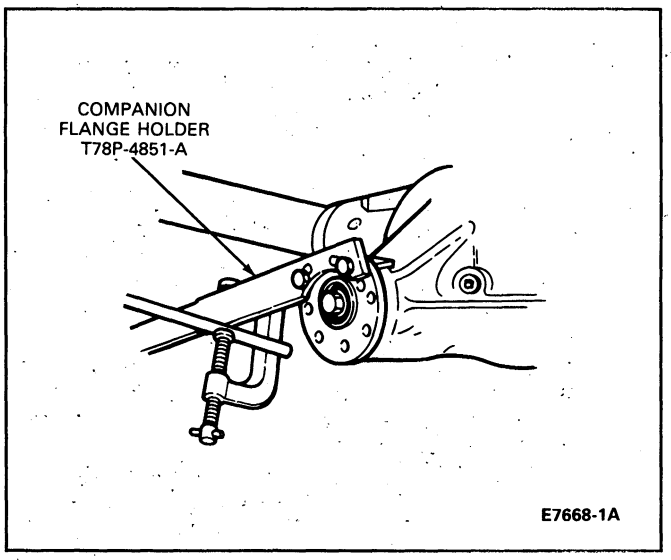


FIG. 6 Lock Axle for Total Backlash Check—Ford E-150 and F/B-150 (later production) Axles

provided between the ring gear and excitor ring for measuring the ring gear backface runout. For excitor ring removal and installation procedures refer to the appropriate rear axle Section.

Limited-Slip Differential Operation Check

Refer to Section 15-42 for Limited-Slip Differential—Dana (E-250/350), Section 15-41 for Limited-Slip Differential—Ford-8.8 inch ring gear (F150/Bronco), and Section 15-43 for Limited-Slip Differential—Ford-10.25 inch ring gear (F-250/350).

To demonstrate the proper performance of the limited-slip differential:

Place one wheel on good, dry surface and the other wheel on ice, mud, snow or greased sheet of plywood.

Gradually open throttle to obtain maximum traction prior to "break-away". The ability to move the vehicle will demonstrate proper performance of a limited slip axle.

When starting with one wheel on an excessively slippery surface, a slight application of the parking brake may be necessary to help energize the limited slip feature of the differential. Release the brake when traction is established. Use light throttle on starting to provide maximum traction.

In vehicle operation, it should be noted that:

1. If, with unequal traction, both wheels slip, the limited-slip axle has done all it can possibly do.
2. In extreme cases of differences in traction, the wheel with the least traction may spin after the limited slip has transferred as much torque as possible to the non-slipping wheel.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. DRIVING THE AXLE WITH THE ENGINE AND ONLY ONE WHEEL RAISED OFF THE GROUND IS NOT A RECOMMENDED PRACTICE WITH EITHER THE LIMITED-SLIP OR CONVENTIONAL AXLE DUE TO THE DANGER OF THE VEHICLE DRIVING OFF THE STAND OR JACK.

Total Axle Backlash Check

Ford Axles

Raise vehicle on hoist. Use a rigid bar or pipe of suitable length and clamp one end to the axle companion flange using Companion Flange Holding Tool T57T-4851-B, for F-Series (half-round flange), and T78P-4851-A for E-Series (circular flange), and the other end to the frame or body member in order to prevent movement of the companion flange (Fig. 5 or Fig. 6).

NOTE: Remove driveshaft when performing this procedure on E-Series.

Lower the vehicle so that one rear wheel is resting on a wheel chock to prevent it from turning. The other rear wheel will then be used to measure total axle backlash.

Rotate the free wheel slowly until a feel of driving the axle is encountered. Position a crayon or chalk firmly on the side of the tire 305 mm (12 inches) from the center of the wheel. Rotate the wheel slowly in the opposite direction until the feel of driving the axle is encountered again.

Measure the length of the crayon or chalk mark on the tire. If the length of the mark is 25.4mm (1 inch) or less, the axle backlash is within allowable limits.

If the chalk mark is greater than 1 inch, check for these conditions:

1. Elongation of the differential pinion shaft holes in the differential case.
2. Missing differential, pinion, or side gear thrust washers.
3. Galling of the differential pinion shaft and bore.
4. Excessive gear set backlash. Follow procedure for type of axle, to check backlash.

Dana Axles

Apply parking brake to keep both rear wheels from turning. Mount a dial indicator Tool D78P-4201-B on the carrier housing with the indicator point positioned to contact the pinion yoke 38.1mm (1-1/2 inch) from the center line of the pinion shaft.

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With the transmission in neutral and engine not running, check the total rotational movement of the pinion yoke. If the total reading on the dial indicator is 1.9mm (0.075 inch) or less, the axle backlash is within allowable limits.

Diagnosis Guides

The diagnosis guides in this Section can be used when diagnosing rear axle and driveline systems.

ADJUSTMENTS

Axle Adjustments

Certain rear axle and driveline trouble symptoms are also common to the engine, transmission, wheel bearing, tires, and other parts of the vehicle. For this reason, be sure that the cause of the trouble is in the rear axle before adjusting, repairing or replacing any of the parts. See Section 18-01, Noise, Vibration and Harshness and the appropriate Section in Group 14 Rear Suspension.

Pinion and Ring Gear Adjustments (All Except Dana)

Two adjustments affect drive pinion and ring gear tooth contact. They are drive pinion depth and backlash (Fig. 7).

The pinion depth adjusting shims are installed between the drive pinion Head and Rear pinion bearing, therefore, adding shims moves the drive pinion towards the ring gear, and removing shims moves the drive pinion away from the ring gear.

On Ford integral axles, backlash is adjusted by adding or removing shims between the differential case side bearings and carrier housing.

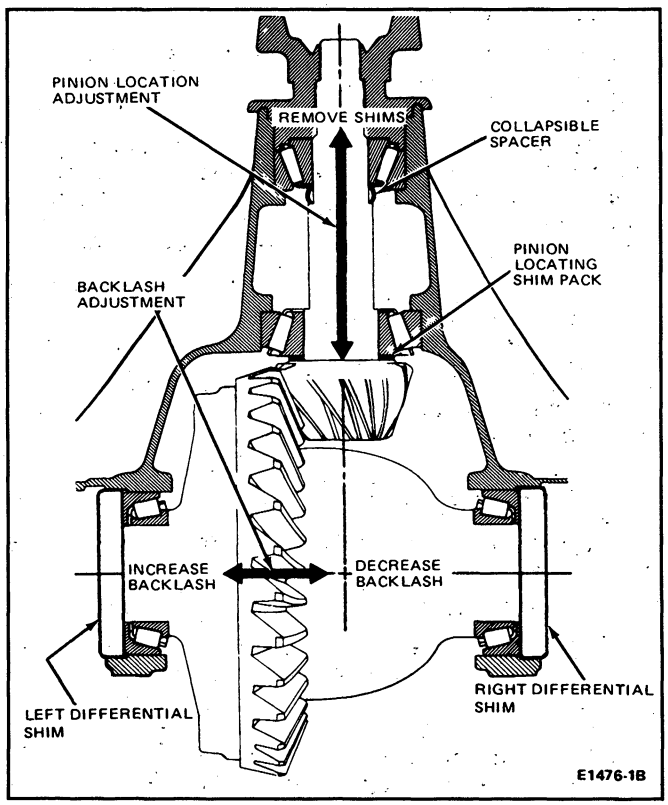


FIG. 7 Pinion and Ring Gear Tooth Contact Adjustment—Integral Carrier Axles

Shim Selection

Individual differences in matching the differential housing and the rear pinion bearing require the use of shims between the drive pinion bearing retainer sleeve and the carrier housing to locate the pinion for correct contact with the ring gear.

Ring Gear Replacement Dana Axles

New Ring Gear bolts should be used to attach a new ring gear to the differential case. Grade 9 bolts with increased torque requirements are now required. Refer to Section 15-0 Integral Carrier Axle—Dana.

Place the new ring gear on the differential case and insert the bolts through the ring gear and into the case and tighten the ring gear bolts to specifications at the end of this Section.

Rear Axle Lubrication

The ability of any axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubricants. To insure long life for gears and bearings, use only specified hypoid gear lubricants. Dana and Ford axles use different lubricants as follows:

- Ford requires ESP-M2C154-A (E0AZ-19580-AA)
- Dana requires ESW-M2C105-A (C6AZ-19580-E)

Draining

Dana Axles

Dana axles do not have a drain plug. The cover should be loosened and removed from the housing to allow drainage. The RTV Sealer must be removed from the cover and axle housing. Reseal with Silicone Rubber, E7TZ-19562-A ESL-M4G273-A or equivalent.

Filling

Ford Axle

The filler hole is in the carrier casting. Fill to the bottom of the hole with the exception of Bronco.

To check these axles for proper lubricant level, the filler plug should be backed out slowly. If seepage occurs around the threads of the plug, immediately turn the plug back in to avoid any drainage. This condition indicates that the specified amount of lubricant is in the axle.

NOTE: The Bronco lube level may be 6.3 mm (1/4 inch) below the filler hole. It is not necessary to fill above this level.

Dana Front and Rear Axles

Fill the axle through the cover filler hole until oil flows from the bottom of the hole. After filling the axle with the specified amount of lubricant, install the oil filler hole plug.

Rear Wheel Bearing and Seal Removal and Installation

Two types of rear wheel bearing assemblies are used in truck axles, full floating and semi floating. Refer to Section 15-05 Integral Carrier Axle—Dana; Section 15-08, Integral Carrier Axle—Ford—8.8 Inch Ring Gear; and Section 15-09, Integral Carrier Axle—Ford—10.25 Inch Ring Gear for removal and installation details.

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The following charts can be used when diagnosing rear axle and driveline systems:

CONDITION	POSSIBLE CAUSE	RESOLUTION
• Excessive rear axle noise.	1. N.V.H. problem. (Noise, vibration and harshness.)	1. Perform the N.V.H. tests to determine whether the noise is a N.V.H. caused by an axle problem. Refer to group 18.
	2. Worn or damaged wheel bearing.	2. Perform wheel bearing noise test. Refer to group 18. Replace bearings if required.
	3. Worn or damaged differential carrier assembly.	3. Remove rear cover. Inspect before disassembly. Repair and replace parts as required.
• Loud "clunk" in the driveline when shifting from reverse to forward.	1. High idle speed.	1. Adjust idle speed.
	2. Loose engine mounts.	2. Inspect, repair as required.
	3. Loose or worn driveshaft components, companion flange attaching nut below specs.	3. Inspect, repair or replace as required.
	4. Inoperative shock absorbers and/or loose rear springs or suspension arms.	4. Inspect, repair or replace as required.
	5. Excessive backlash in axle, or transmission.	5. Perform total backlash check of axle. Repair or replace as necessary.
	6. Insufficient lubrication.	6. Add lubricant as required.
• Driveline "clunk" as vehicle starts to move following a brake stop (2-piece driveshaft).	1. Loose rear spring U-bolts.	1. Tighten U-bolts to specification.
	2. Worn or galled output shaft splines.	2. Remove the driveshaft from the vehicle. Clean the male splines and inspect for worn or galled splines. Replace if necessary.
	3. Worn or galled slip yoke splines.	3. Clean and inspect the female splines of the slip yoke for worn or galled condition. Replace if necessary.
	4. Damaged slip yoke seal.	4. Replace seal.
	5. Insufficient lubrication.	5. Using a long handle (stencil type) brush, apply long life lube evenly on all the splines of the slip yoke. Reinstall driveshaft and using a hand grease gun lubricate the slip yoke thru the zerk fitting with long life lube C1AZ-19590-BA (ESA-M1C75-B) or equivalent. NOTE: Install the slip yoke making sure that the coupling shaft and driveshaft are in phase.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• On turns, DANA limited slip axle has a high pitched chattering noise.	1. Improper lubricant. Dana axles use different lube than Ford axles. Use C6AZ-19580-E (ESW-M2C105-A) in Dana axles.	1. If axle chatters, siphon or drain lubricant from axle and refill with specified rear axle lubricant, and dosage of friction modifier additive.
• DANA limited slip axle does not work in snow, mud or ice.	1. Worn or damaged axle unit.	1. Starting with one wheel on a slippery surface, slightly apply the parking brake. Gradually open throttle. If the vehicle moves, the axle is operating satisfactorily.
• Driveline concerns.	1. Rear spring U-bolt loose.	1. Retighten U-bolts and driveshaft.
	2. U-joint worn or improperly installed.	2. Reinstall or replace U-joint.
	3. Coupling shaft center support bearing improperly installed.	3. Correctly install bearing and replace if damaged.
	4. Excessive runout in companion flange and damaged U-joint.	4. Rotate flange 180° and reinstall. Recheck and if not acceptable, replace flanges and/or U-joint and repair as required.
	5. Excessive lateral and radial tire and wheel runout.	5. Refer to Section 11-01, General Wheel and Tire Service.
	6. Excessive driveshaft runout.	6. Replace driveshaft or rotate driveshaft 180° and check for out-of-balance condition.
	7. Driveshaft out-of-balance.	7. Rebalance driveshaft.
	8. Driveline and pinion angles out-of-specification.	8. Adjust to specifications.
	9. Binding, damaged or galled splines on slip yoke.	9. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Long-Life Lube C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

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REAR AXLE DIAGNOSIS GUIDE — FORD AXLES

CONDITION	POSSIBLE CAUSE	RESOLUTION
Excessive rear axle noise.	1. Differential carrier.	1. Road test vehicle to assure problem is rear axle noise rather than other system noise. Refer to General Diagnostic Procedure. Repair and replace parts as required.
Loud "clunk" in the driveshaft when shifting from reverse to forward.	1. Driveshaft. 2. Rear axle shafts or carrier.	1. Raise vehicle, rotate driveshaft by hand to isolate problem as driveshaft or rear axle problem. Repair or replace as required. 2. Remove and inspect. Repair as necessary.
Limited-slip axle does not work in snow, mud or on ice.	1. Differential.	1. Perform Differential Operation Check in this Section. Repair as required.
On turns, the rear axle has a high pitched chattering noise (Limited-slip axles only).	1. Lubricant. 2. Differential.	1. Road test vehicle — drive truck in tight circles, 5 clockwise and 5 counterclockwise. If chatter is still evident, flush and replace lubricant. (See Lubricant Specifications at the end of this Section.) 2. Remove differential, repair as required.
Noise is the same on drive or coast.	1. Road noise. 2. Tire noise. 3. Front wheel bearing noise.	1. Normal Condition. 2. Rebalance or replace tire. 3. Adjust or replace wheel bearings.
Noise changes with type of road.	1. Road noise. 2. Tire noise.	1. Normal Condition. 2. Rebalance or replace tire.
Noise tone lowers as truck speed is lowered.	1. Tire noise.	1. Rebalance or replace tire.
Similar noise is produced with truck standing and driving.	1. Engine noise. 2. Transmission noise.	1. Refer to Section 21-01, Engine — Volume B*. 2. Refer to Section 17-01, General Automatic Transmission Service.
Vibration.	1. Refer to Noise, Vibration and Harshness, Section 18-01.	1. Refer to Noise, Vibration and Harshness, Section 18-01.
Noise most pronounced on turns.	1. Differential side gears and pinion gears.	1. Replace gears.
Drive noise, coast noise, or float noise.	1. Wheel bearings or differential side bearings. 2. Ring and pinion gear.	1. Adjust or replace wheel or differential side bearings. 2. Check ring and pinion gear. Adjust or replace.
Clunk on acceleration or deceleration.	1. Worn differential pinion shaft in case.	1. Replace differential pinion shaft.

*Engine manual — Volume B may be purchased separately. CE3742-2E

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CHATTERS ON TURNS WITH NO LIMITED SLIP DIFFERENTIAL

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	DRIVE VEHICLE		
	Drive vehicle in fairly tight figure 8's — ten times total. (Five clockwise and five counterclockwise).	No Chatter ▶	STOP.
		Chatter still present ▶	GO to 2.
2.0	CHANGE LUBRICANT		
	Siphon or drain lubricant from axle and refill with specified rear axle lubricant①. Drive vehicle in fairly tight figure 8's — ten times total. (Five clockwise and five counterclockwise).	No Chatter ▶	STOP.
		Chatter still present ▶	GO to 3.
3.0	DRIVE VEHICLE		
	Drive vehicle 40-80 km (25-50 miles) in addition to figure 8's.	No Chatter ▶	STOP.
		Chatter still present ▶	REMOVE the differential and REPAIR as required.

① F-150, Bronco, E-150 with Ford 8.8 Limited Slip add 4 oz. of Additive Friction Modifier (EST-M2C118-A) C8AZ-19B546-A or equivalent. E-250—350 with Dana Limited Slip or F-250-350 with Ford 10.25 Limited Slip add 8 oz. of Additive Friction Modifier (EST-M2C118-A) C8AZ-19B546-A or equivalent. **CE4767-2H**

LIMITED SLIP DIFFERENTIAL DOES NOT OPERATE IN MUD OR SNOW OR ON ICE

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	ALL FORD AND DANA MODEL 60 AND 70		
	Starting with one wheel on an excessively slippery surface, slightly apply the parking brake. Gradually open throttle, if the vehicle moves, the axle is operating properly.	Vehicle moves ▶	Unit OK. STOP.
		Vehicle doesn't move ▶	REPAIR Unit as required.

CE4768-2C

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DRIVELINE COMPLAINTS

CONDITION	POSSIBLE CAUSE	RESOLUTION
Driveline Concerns	1. Rear spring U-bolt loose.	1. Retighten U-bolts and driveshaft.
	2. U-joint worn or improperly installed.	2. Install or replace U-joint.
	3. Coupling shaft center support bearing improperly installed.	3. Correctly install bearing and replace if damaged.
	4. Excessive runout or damaged U-joint.	4. Rotate flange 180 degrees and install. Recheck, and if not acceptable, replace flanges and/or U-joint and repair as required.
	5. Excessive lateral and radial tire and wheel runout.	5. Refer to Section 11-01, General Wheel and Tire Service.
	6. Excessive driveshaft runout.	6. Replace driveshaft or rotate driveshaft 180 degrees and check for out-of-balance condition.
	7. Driveshaft out-of-balance.	7. Rebalance driveshaft.
	8. Driveline and pinion angles out-of-specification.	8. Adjust to specifications.
	9. Binding, damaged or galled splines on slip yoke.	9. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B).
Noise on Drive or Coast	1. Improper driveline angles or phasing.	1. Adjust or correct as required.
Loud clunk in the Driveline when shifting from reverse to forward.	1. Loose or worn driveshaft components, companion flange attaching nut below specifications.	1. Inspect, repair, replace as required.

CE4771-2G

Light trucks under 8500 lbs. GVW have semi-floating axles which are equipped with straight roller bearings. The oil seal is outboard of the bearings. Full service procedures for these bearings and seals are provided in Section 15-05 Integral Carrier Axle—Dana and Section 15-08, 15-09 Integral Carrier Axle—Ford—8.8/10.25 Inch Ring Gear.

Rear Axle Companion Flange Runout Check—F-Series

1. Raise the vehicle on a hoist that supports the rear axles (twin-post hoist).
2. Remove the driveshaft assembly (Section 15-60 Driveshaft—Single Snap Ring Type U-Joint).
3. Check the companion flange for damage to the universal joint bearing locating lugs. If the lugs are shaved (worn) or damaged, replace the flange (Fig. 8).
4. The companion flange runout is checked with a dial indicator such as D78P-4201-B or equivalent, with 25.40mm (1.000 inch) minimum travel, and a cup-shaped dial indicator adapter TOOL-6565-AC (Fig. 9). To fabricate the checking tool, modify a universal joint assembly by removing two bearing cups that are opposite each other, and cutting or grinding off one of the universal joint bearing flanges (Fig. 9).
5. Install the cup-shaped adapter on the dial indicator stem. Install the dial indicator on the pinion retainer or pinion nose bumper bracket. Position the indicator to allow an indication at the ends of the universal joint bearing cups and the remaining exposed journal of the cross-shaft.
6. Turn the companion flange so that the dial indicator cup-type adapter rests on the machined surface of the bearing cup (Fig. 9). Rotate the companion flange side-to-side slightly to obtain a reading indicating that the bearing cup surface is perpendicular to the adapter. **This will be the point at which the dial indicator cup is closest to the center of companion flange rotation. It is also the point at which the dial indicator hand will reverse direction as the companion flange is turning.**
7. Carefully retract the dial indicator stem and rotate the companion flange 180 degrees to position the machined surface of the opposite universal bearing under the dial indicator adapter tool. Again, slightly rotate the flange side-to-side to position the bearing perpendicular to the dial indicator adapter. Again, this is the point at which the indicator hand will reverse direction as the flange is rotated. Record the flange bearing cup runout reading obtained from the indicator (Fig. 10).

Rotate the companion flange 90 degrees and position the dial indicator adapter on the machined end of the exposed journal (Fig. 11). **Be sure the end surface of the journal is perpendicular to**

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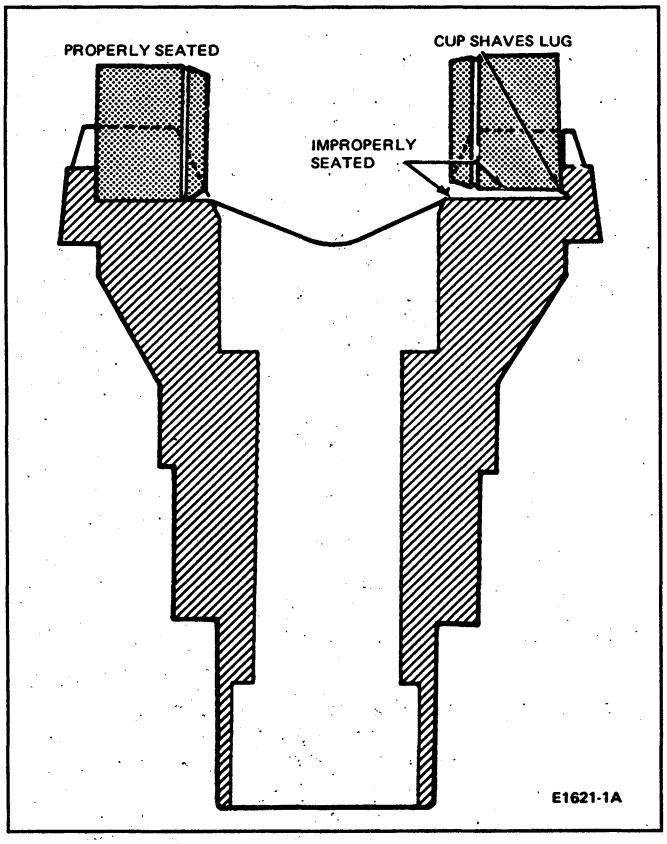


FIG. 8 Checking Companion Flange

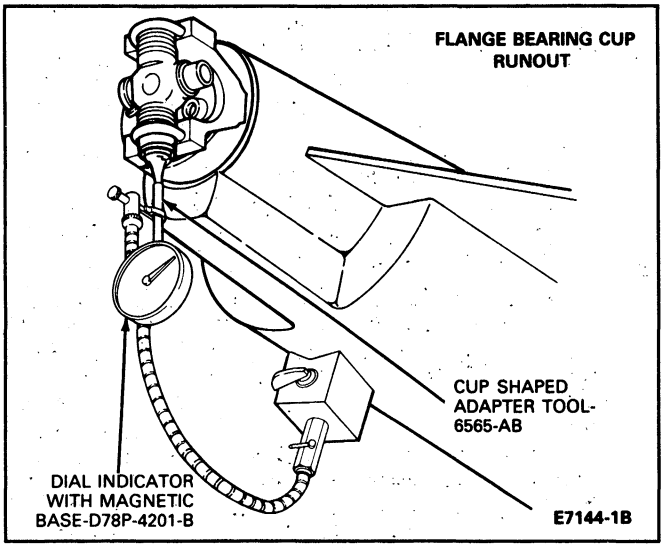


FIG. 9 Flange Bearing Cup Runout

the adapter. This requires that the cross-shaft be moved fore and aft on the flange bearing cups. **Note the point at which the indicator hand reverses direction.**

Rotate the flange assembly side-to-side until the cross-shaft is perpendicular to the pinion shaft axis, and the indicator hand reverses direction. Zero the dial indicator and check the zero point again by slightly moving the cross-shaft fore and aft; then, rotate the companion flange from side-to-side.

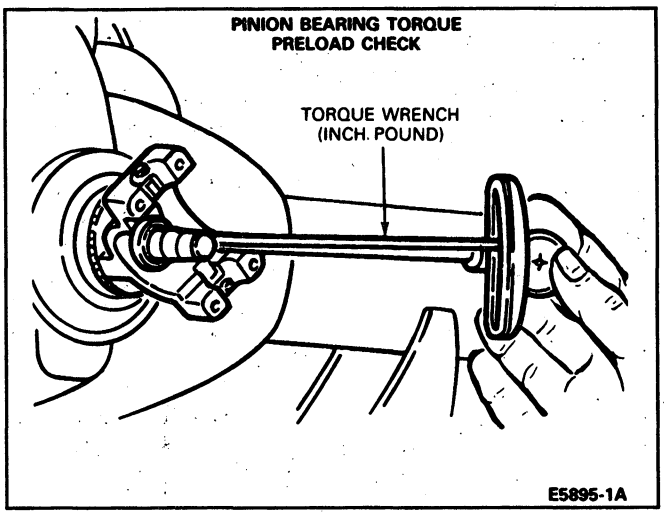


FIG. 10 Pinion Bearing Torque, Preload Check

Indicator Reading	Flange Bearing Cup Runout—Inch	Driveshaft Universal Cross-Shaft Runout—Inch
1	0.004	0.005
2	0.002	0.004
3	0.003	0.003
Average	0.003	0.004

CE1943-1B

FIG. 11 Flange Bearing Cup and Cross-Shaft (V2) Runout Averaging Chart—Typical Reading

8. With the indicator at zero, carefully retract the dial stem and rotate the flange 180 degrees. Rotate the cross-shaft 180 degrees on the flange bearing cups to position the exposed journal under the dial indicator adapter. Rock the cross-shaft fore and aft and the companion flange side-to-side to establish the point at which the indicator hand reverses direction. This will determine the driveshaft universal cross-shaft runout. Record this reading (Fig. 11).
9. **Repeat Steps 5 through 8 at least three times and average the indicator readings obtained (Fig. 10).**
10. To determine the total (combined) companion flange runout, use the combined runout guide (Fig. 12). With an indicated 0.003-inch flange bearing cup runout and an indicated 0.004-inch universal cross-shaft runout (Fig. 11), the combined companion flange runout will be 0.005-inch (Fig. 12).
11. If the reading obtained in Step 10 exceeds specifications, re-position the companion flange 180 degrees on the pinion shaft and repeat Steps 1 through 11.

CAUTION: BEFORE removing the companion flange, check and record the pinion nut torque. Also, check and record the pinion bearing preload, (Fig. 10). Original readings must be repeated after the companion flange is repositioned.

Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is

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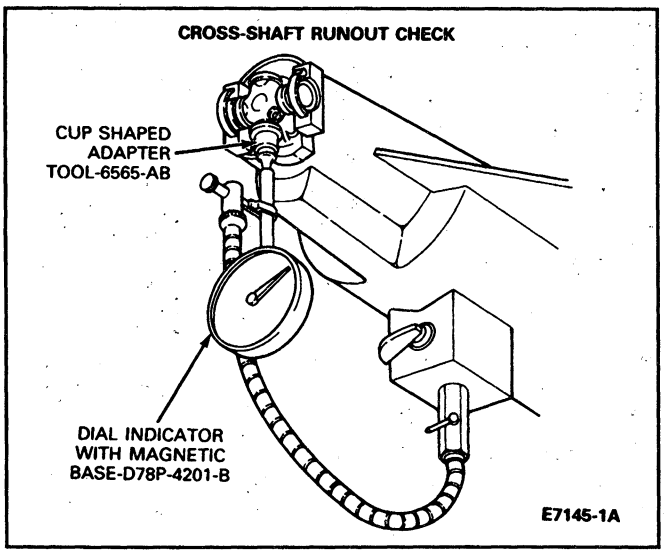


FIG. 12 Cross-Shaft Runout Check

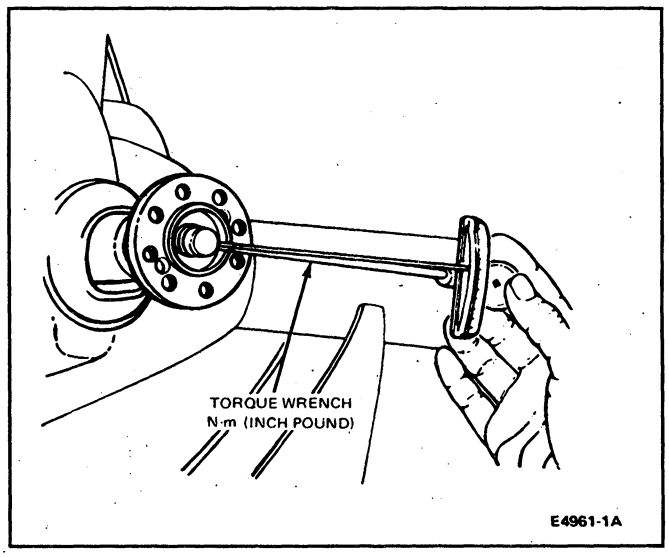


FIG. 13 Pinion Bearing Torque Preload Check (Circular Flange Shown)

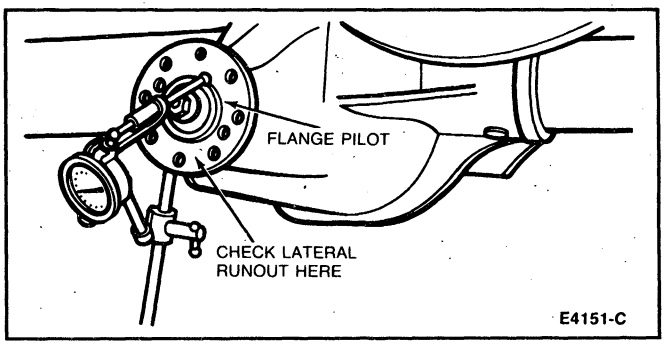


FIG. 14 Lateral Runout Check

required, a new collapsible pinion spacer and pinion nut must be installed.

12. If the repeat readings still exceed specifications, re-position the flange an additional 90 degrees on the pinion shaft and check the runout (Steps 4 through 10).
13. If the runout is still excessive, replace the companion flange and check the runout. If necessary, rotate the new flange on the pinion shaft until an acceptable runout is obtained.

    If excessive runout is still evident after replacement of the companion flange, replace the ring gear and pinion and repeat the above checks until the runout is within specifications.
14. Install the driveshaft assembly (Section 15-60 General Driveshaft Service). **Make sure the universal joint bearing cups are properly positioned between the companion flange lugs.**
15. Lower the vehicle. Road test the vehicle. If driveshaft vibrations are evident during the road test, remove the driveshaft from the companion flange and rotate it 180 degrees. Road test the vehicle again.

Rear Axle Circular Flange Runout Check-8.8 inch Ring Gear—E-Series and (F-150/Bronco in Later Production)

1. Raise the vehicle on a hoist that supports the rear axle (twin post hoist). Refer to the Pre-Delivery manual, Section 50-04.
2. Remove the driveshaft assembly. Refer to Sections 15-60 and 15-66.
3. Check the circular flange for damage.
4. To check radial runout, set up dial indicator.
5. Rotate the circular flange with the dial indicator in place. If the runout exceeds specifications (refer to specific axle Section for specifications), remove the flange and install it 180 degrees from original position. Follow the procedure in Sections 15-60 and 15-66 for companion flange installation.

CAUTION: BEFORE removing the circular flange, check and record the pinion nut torque. Also, check and record the pinion bearing preload, (Fig. 13). Original readings must be repeated after the circular flange is repositioned.

Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.

6. If runout is still excessive, remove and install flange an additional 90 degrees and check runout.
7. To check lateral (face) runout, set up the dial indicator. Repeat Steps 5 and 6.
8. If runout is still excessive, replace companion flange and check runout. If necessary, rotate the new flange on the pinion shaft until an acceptable runout is obtained.

   If excessive runout is still evident after replacement of the circular flange, it will be necessary to replace the ring and pinion gear, and repeat the above checks until runout is within specifications.
9. Install the driveshaft assembly as described in Sections 15-60 and 15-66.

CLEANING AND INSPECTION

Inspection Before Carrier Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the carrier casting. These inspections can help find the

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Flange Bearing Cup Runout	Driveshaft Universal Cross-Shaft Runout — Inch												
	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.000	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.001	0.001	0.0013	0.0022	0.0032	0.0042	0.0051	0.0061	0.0071	0.0081	0.0091	0.0010	0.011	0.012
0.002	0.002	0.0022	0.0027	0.0037	0.0045	0.0053	0.0062	0.0072	0.0082	0.0092	0.0101	0.0111	0.0121
0.003	0.003	0.0032	0.0036	0.0042	0.005	0.0058	0.0067	0.0077	0.0085	0.0094	0.0104	0.0113	0.0123
0.004	0.004	0.0042	0.0045	0.005	0.0057	0.0064	0.0072	0.0081	0.009	0.0097	0.0107	0.0116	0.0126
0.005	0.005	0.0051	0.0053	0.0058	0.0063	0.0071	0.0078	0.0087	0.0094	0.0102	0.0111	0.012	0.013
0.006	0.006	0.0061	0.0062	0.0068	0.0072	0.0078	0.0085	0.0092	0.010	0.0108	0.0116	0.124	0.0134
0.007	0.007	0.0071	0.0073	0.0075	0.0081	0.0087	0.0093	0.0099	0.0103	0.0114	0.0122	0.013	0.0138
0.008	0.008	0.0081	0.0082	0.0087	0.009	0.0094	0.010	0.0104	0.011	0.012	0.0128	0.0135	0.0144
0.009	0.009	0.0091	0.0092	0.0094	0.0097	0.102	0.108	0.0114	0.012	0.0127	0.0134	0.0141	0.015
0.010	0.010	0.010	0.0101	0.0104	0.0107	0.0111	0.0116	0.0122	0.0128	0.0134	0.0141	0.0148	0.0156
0.011	0.011	0.011	0.0111	0.0113	0.0116	0.012	0.0124	0.013	0.0135	0.0141	0.0148	0.0154	0.0162
0.012	0.012	0.012	0.0121	0.0123	0.0126	0.013	0.0134	0.0138	0.0144	0.015	0.0156	0.0162	0.0169

The total (combined) companion flange runout is located in the square where the columns containing the flange bearing cup runout and universal cross shaft runout readings intersect.

CE3683-2A

FIG. 15 Companion Flange Combined Runout Chart

cause of the concern and determine the correction needed.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate worn or damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.
4. Set up a dial indicator (Figs. 16, 17 and 18), and check ring gear backlash and ring gear backface runout.

   NOTE: On F-Series and Bronco vehicles equipped with Rear Antilock Brakes (RAB), mount Dial Indicator with Bracketry, TOOL-4201-C, or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear (Fig. 17). There is a space provided between the excitor ring and the ring gear for measuring ring gear backface runout.
5. Proper gear set assembly must be checked using the Pinion Depth Gauge T79P-4020-A or equivalent which shows correct pinion shim required to assure acceptable running condition.

Inspection After Carrier Disassembly

All Axles

Thoroughly clean all parts. Synthetic seals must not be cleaned, soaked or washed in cleaning solvents. Always use clean solvent when cleaning bearings. Oil the bearings immediately after cleaning, to prevent rusting. Inspect the parts for wear or damage. If rust is present, remove with a wire brush mounted on a power drill or equivalent. Rinse clean with metal-prep solvent on sponge or rag to remove all particles. With a clean sponge, coat tube interior with Dupont 3012-5 Red Oxide Preparakote or equivalent. Allow to dry for a minimum of one hour.

When a scored gear set is replaced, the axle housing should be washed thoroughly. This can only be done effectively if the axle shafts and shaft seals are removed from the housing. Inspect individual parts as outlined below.

Gears

Examine the pinion and ring gear teeth for scoring or excessive wear. Worn gears cannot be rebuilt to correct a noisy condition. Gear scoring is the result of excessive shock loading or the use of an incorrect lubricant. Scored gears cannot be reused. Examine the teeth and thrust surfaces of the differential gears. Wear on the hub of the differential side gear can cause a chucking noise known as chuckle when the vehicle is driven at low speeds. Wear of splines, thrust surfaces, or thrust washers, can contribute to excessive driveline backlash.

Sensor

Inspect the Rear Antilock Brake System Sensor (RABS) pole piece for loose metal particles and clean if required.

Excitor Ring

Examine the Rear Antilock Brake System (RABS) excitor ring to see that it is firmly pressed on to the differential case and check it for damaged (dented, chipped or missing) teeth that could result in erratic RABS performance. If damage is found, remove and replace excitor ring.

Bearing Cups and Cone and Roller Assemblies

Check bearing cups for rings, scores, galling, or excessively worn wear patterns. Pinion bearing cups must be solidly seated in the housing bores. Check for seating by attempting to insert a 0.04mm (0.0015-inch) feeler between these cups and the bottoms of their bores.

NOTE: For 1989, the Dana Econoline axles include spacers outboard of the differential bearing cups to protect the housing if the bearing cup has spun in the housing. The Model 80 axle in the Super Duty has had the spacers since 1988 model introduction. Prior to 1989, the Econoline bearing cups were bonded to the housing.

When operated in the bearing cups, cone and roller assemblies must turn without roughness. Examine the large roller ends for wear. If the original blend radius has worn to a sharp edge, the bearing should be replaced.

If inspection reveals either a worn bearing cup or a worn cone and roller assembly, both parts should be replaced to avoid damage.

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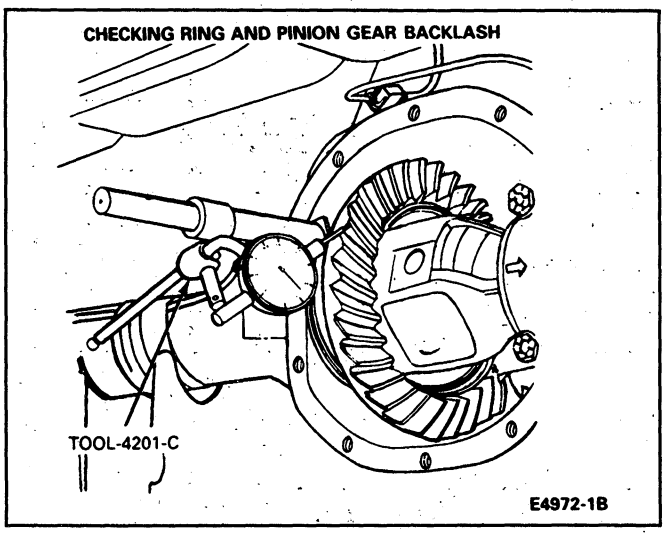


FIG. 16 Ring and Pinion Gear Backlash Check

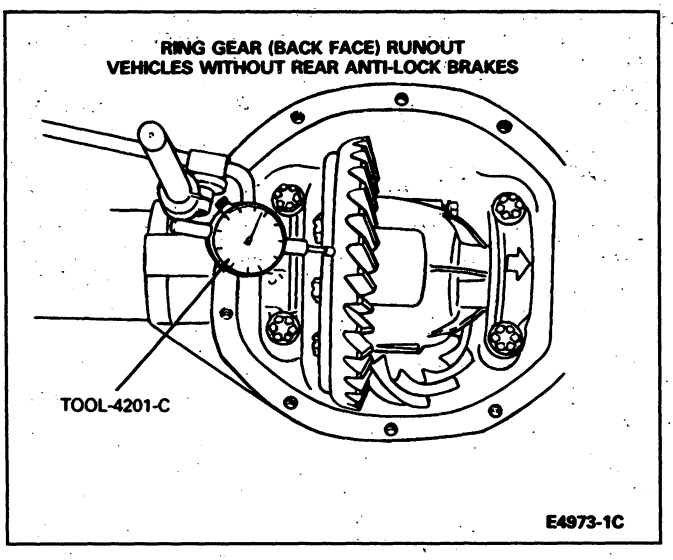


FIG. 17 Ring Gear Runout Check—Vehicles Not Equipped with Rear Antilock Brakes

Pinion Flange

Be sure that the surfaces of the pinion flange have not been damaged in removing the driveshaft or in removing the flange from the axle. The end of the pinion flange that contacts the front pinion bearing inner race or slinger washer, as well as the flat surface of the pinion nut counterbore, must be smooth. Polish these surfaces if necessary. Roughness aggravates backlash noises and causes wear of the flange and pinion nut, with a resultant loss in pinion bearing preload.

Carrier Housing

Make sure that the differential bearing bores are smooth (if applicable). Remove any nicks or burrs from the mounting surfaces of the carrier housing.

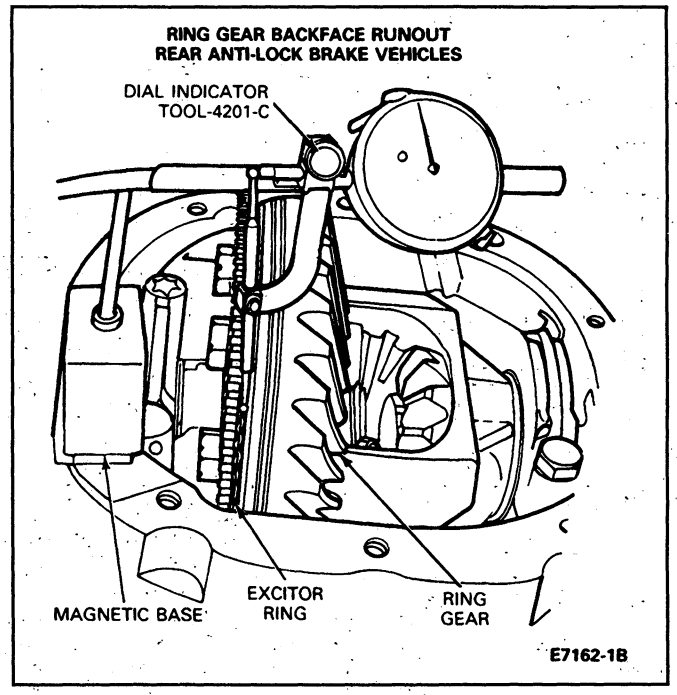


FIG. 18 Ring Gear Backface Runout Check—Vehicles Equipped with Rear Antilock Brakes

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

NOTE: Care should be taken to prevent damage to the RABS excitor ring while handling and servicing the differential case.

Limited-Slip Differential Parts

Inspect the clutch plates for uneven or extreme wear. The dog eared clutch plates must be free from burrs, nicks or scratches which could cause excessive or erratic wear to the internally splined clutch plates. The internally splined clutch plates should be inspected for condition of the material, and wear. Replace the plates if their thickness is less than 1.5mm (0.058-inch) or if the material is scored or badly worn. Inspect the plate internal teeth for wear. Replace them, if excessive wear is evident.

Plates should be replaced as a set only. Examine all thrust surfaces and hubs for wear. Abnormal wear on these surfaces can contribute to a noisy axle.

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SPECIFICATIONS

FRONT AND REAR AXLE LUBRICANT CAPACITIES

Axle Model	Vehicle	Approximate Capacity		
		U.S. Pints	Imperial Pints	Liters
Ford Axle — 8.8 Inch Ring Gear③	F-150 Bronco	5.5	4.6	2.6
	E-150	5.5	4.6	2.6
Ford Axle 10.25 Inch Ring Gear⑤	F-250-350 (4x2) — Dual Rear Wheels F-250-350 (4x4)	7.5④	6.3	3.5
Dana 44 IFS — Front ①	F-150 (4x4), Bronco	3.6	3.0	1.7
Dana 44 IFS-HD — Front①	F-250 (4x4)	3.6	3.0	1.7
Dana 50-IFS — Front①	F-250 (4x4) HD	3.8	3.2	1.8
Dana 60 — Front	F-350 (4x4)	5.9	4.9	2.8
Dana 60-IU — Rear ②	E-250 — 350 SRW	6.25	5.2	3.0
Dana 70 — Rear②	E-350 Dual Rear Wheel	6.6	5.5	3.1
Dana 80 — Rear	F-Super Duty Chassis Cab, Commercial Stripped Chassis and Motor Home Chassis	8.25	6.9	3.9

①Add 2 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Dana Front Drive Axle with limited slip differential.
②Add 8 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Dana rear axles with limited slip differentials.
③Add 4 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Ford 8.8 inch limited slip rear axles.
④7.5 pints is the factory fill. In vehicle fill is 6.5 pints. Ford 10.25 inch Axles with Limited Slip differentials.
⑤Add 8 oz. of Additive Friction Modifier, C8AZ-19B546-A(EST-M2C118-A) or equivalent to Ford 10.25 inch ring gear Limited-Slip Axles. CE5089-2G

RING GEAR TORQUE SPECIFICATIONS

Model	Torque Limits	
	N-m	Ft-Lbs
Ford 8.8 inch ring gear	95-115	70-85
Ford 10.25 inch ring gear	136-163	100-120
Dana 44 and 50	68-81	50-60
Dana 60-IU	136-163	100-120*
Dana 70, 70-H.D.	136-163	100-120*
Dana 80	285-311	210-230

*Grade 9 screws. Identified by 7 radial lines on head. Grade 8 screws are no longer recommended for service. CE4770-1G

ROTUNDA EQUIPMENT

Model	Description
006-01400	Transducer/Balancer

CE5577-1C

SPECIAL SERVICE TOOLS

Number	Description	Application
TOOL-4201-C	Dial Indicator with Bracketry	Axle Adjustments
D78P-4201-B	Dial Indicator — Magnetic Base	Axle Adjustments
T57T-4851-B	Companion Flange Holding Tool	Axle Adjustments
TOOL-6565-AB	Cup Shaped Adapter	U-Joint Checking
T78P-4851-A	Companion Flange Holding Tool	Axle Checking
T79P-4020-A	Pinion Depth Gauge	Axle Adjustments

CE7669-2B

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SECTION 15-05 Integral Carrier Rear Axle—Dana

SUBJECT	PAGE
ADJUSTMENTS	15-05-6
ASSEMBLY	
Assembly of Differential Into Housing	15-05-29
Depth Gauge Check	15-05-26
Differential Case	15-05-22
Final Assembly—Differential into Housing	15-05-31
Pinion Bearing Cup Installation	15-05-26
CLEANING AND INSPECTION	
Inspection Before Disassembly	15-05-21
DESCRIPTION AND OPERATION	15-05-1
DIAGNOSIS AND TESTING	15-05-6
DISASSEMBLY	15-05-14
REMOVAL AND INSTALLATION	
Drive Pinion Oil Seal	15-05-6
Oil Seal and Wheel Bearing—Full Floating Axle	15-05-14
Oil Seal and Wheel Bearing—Semi-Floating Axle	15-05-13
Rear Axle	15-05-9
Rear Axle Shaft—Full Floating Axle	15-05-13
Rear Axle Shaft—Semi-Floating Axle	15-05-10
SPECIFICATIONS	15-05-35
VEHICLE APPLICATION	15-05-1

VEHICLE APPLICATION

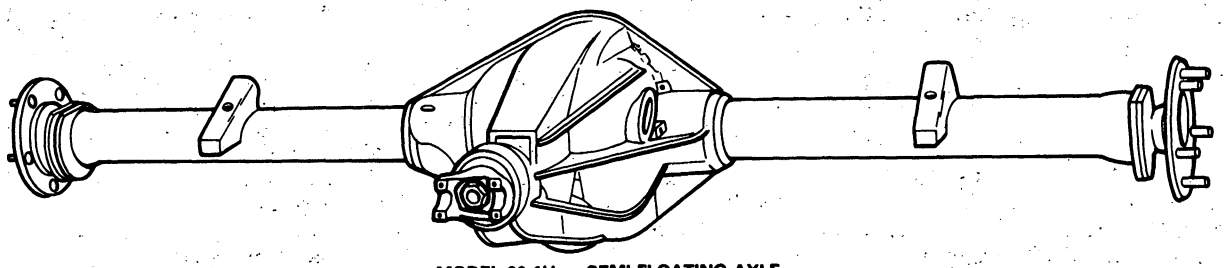
E-250 Through E-350 and F-Super Duty Vehicles.

DESCRIPTION AND OPERATION

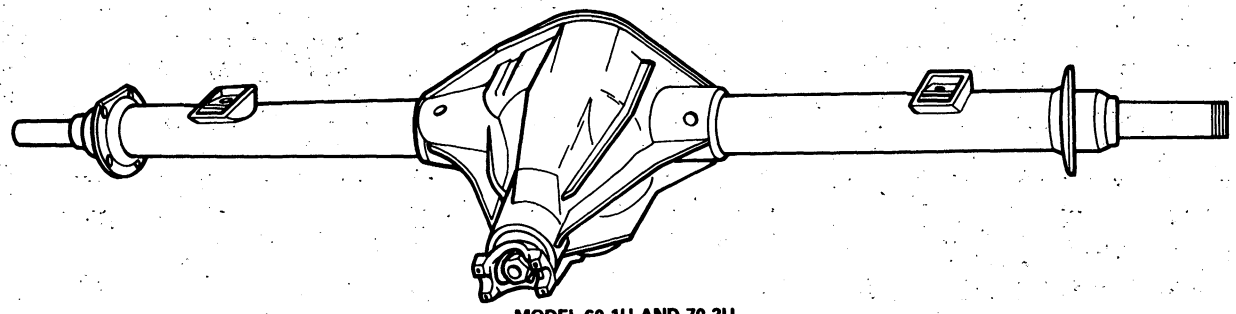
Several models of Dana rear axles are used in regular production or are available as options on the E-250—E-350 and F-Super Duty Vehicles.

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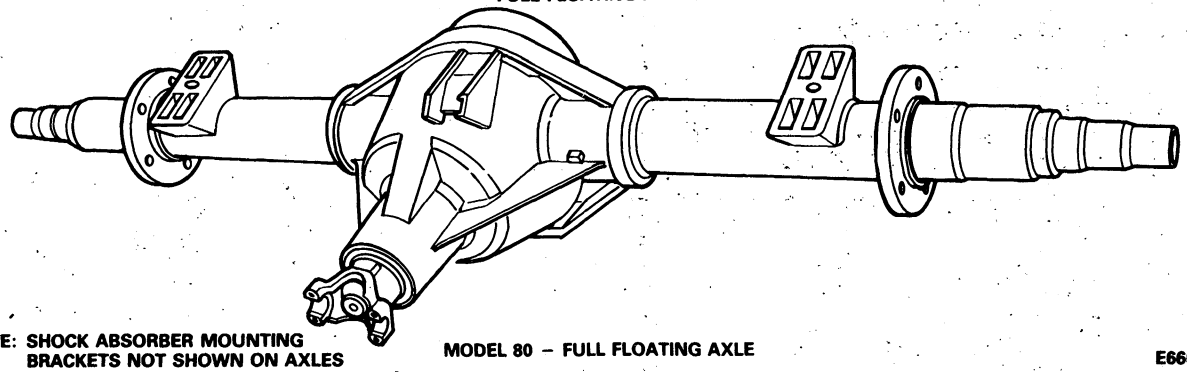
DESCRIPTION AND OPERATION (Continued)



MODEL 60-1U – SEMI-FLOATING AXLE



MODEL 60-1U AND 70-2U
FULL FLOATING AXLES



NOTE: SHOCK ABSORBER MOUNTING BRACKETS NOT SHOWN ON AXLES

MODEL 80 – FULL FLOATING AXLE

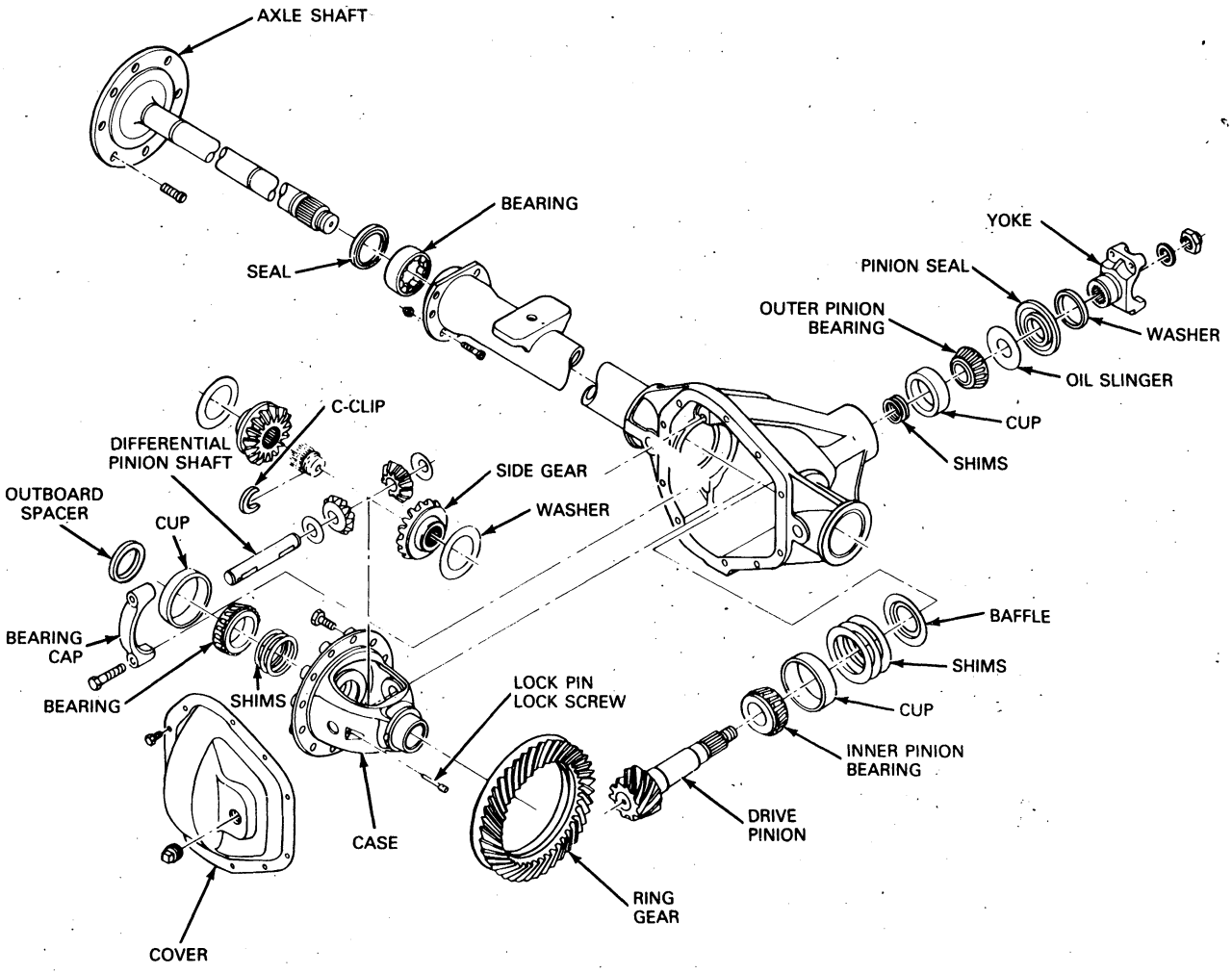
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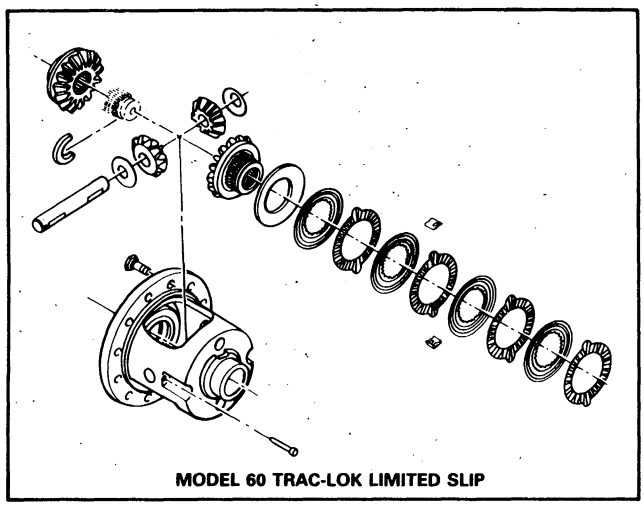
The Model 60-1U semi-floating rear axle is used on light duty E-250. The Model 60-1U full floating rear axle with single rear wheels is used on heavy duty E-250 and E-350. The model 70-1HD and 70-2U full-floating dual rear wheel axle are found on E-350. The Model 80 full-floating, dual rear wheel axle is used on F-Super Duty vehicles.

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DESCRIPTION AND OPERATION (Continued)

MODEL 60-1U SEMI-FLOATING AXLE



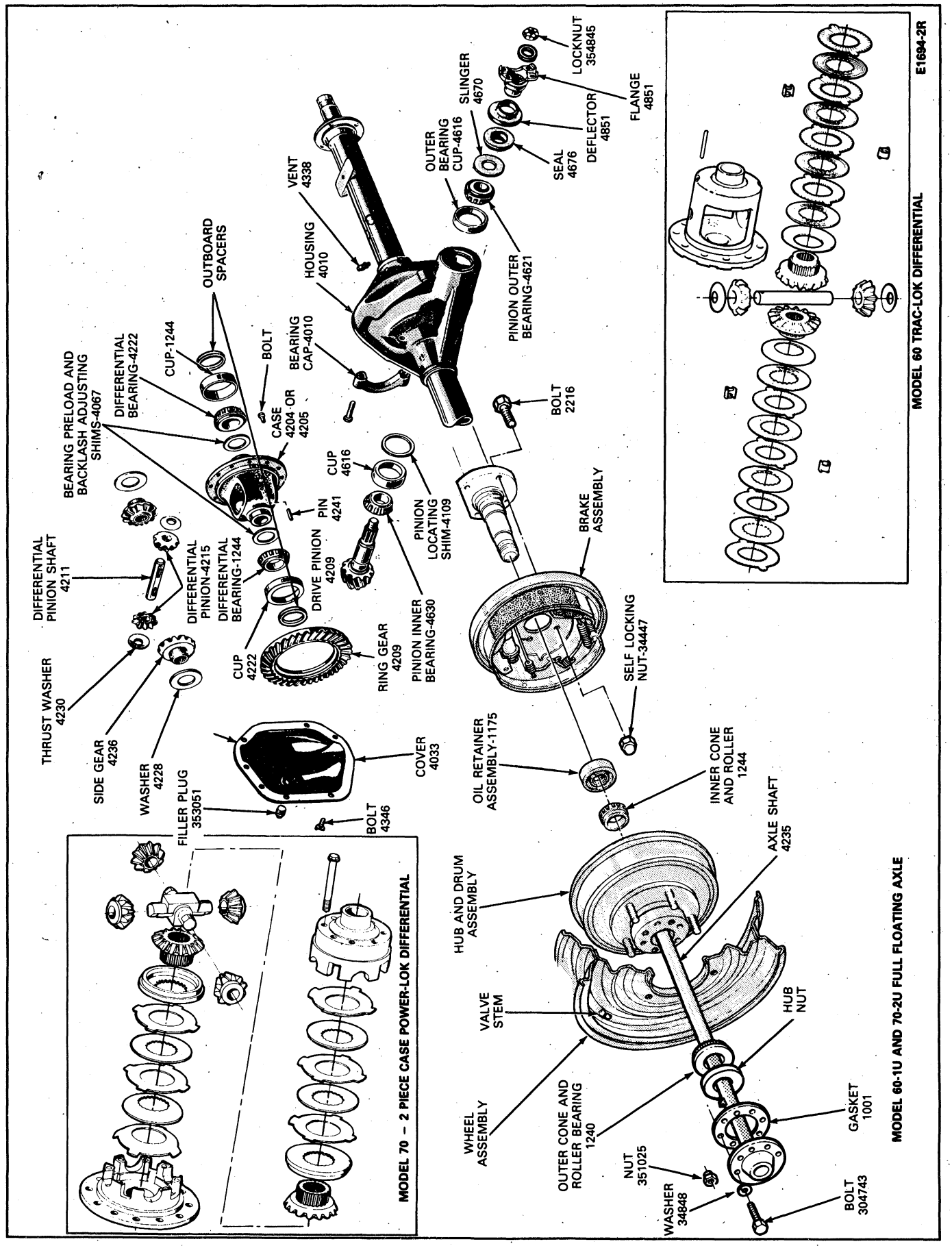


MODEL 60 TRAC-LOK LIMITED SLIP

E4831-2D

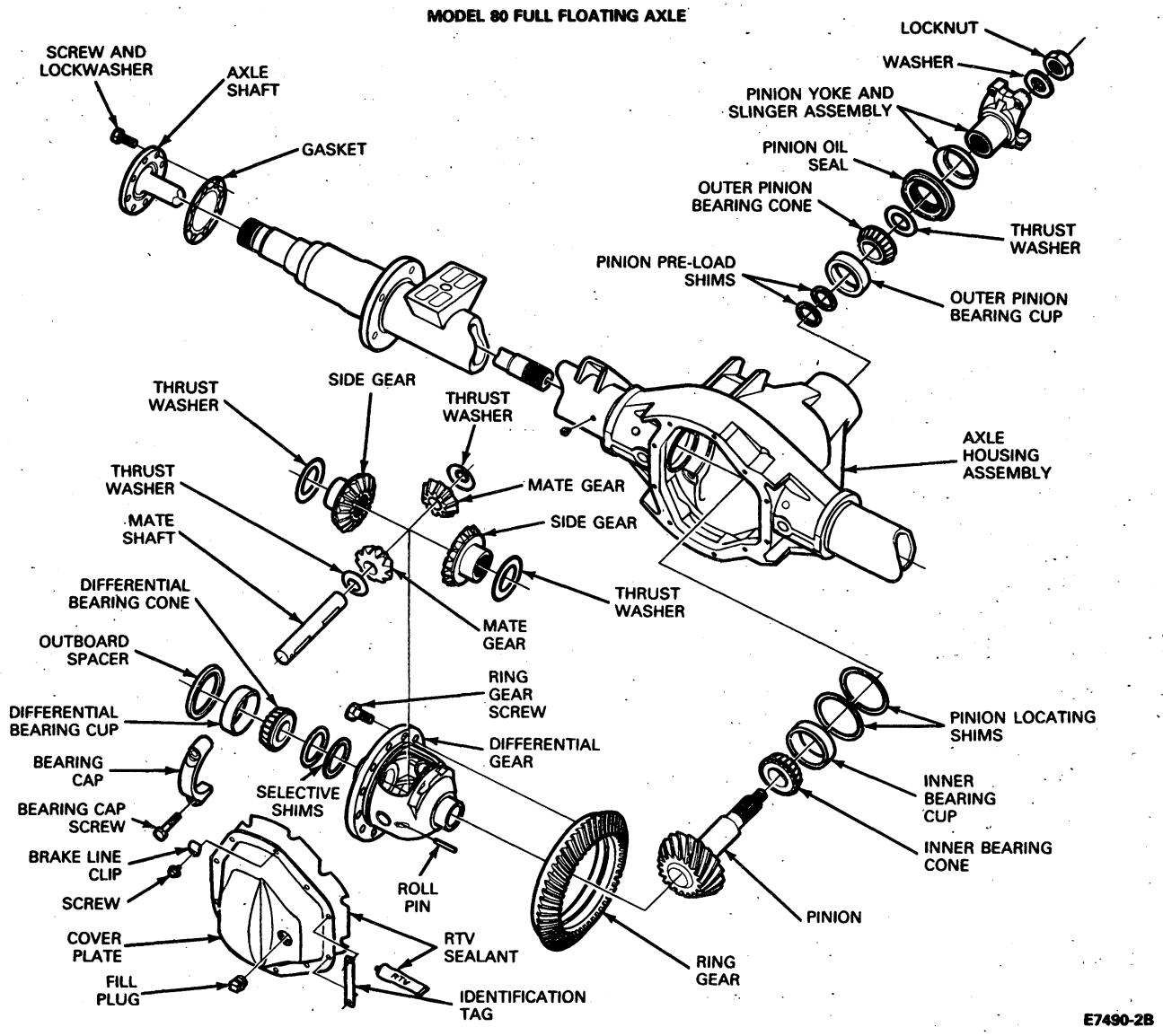
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DESCRIPTION AND OPERATION (Continued)



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DESCRIPTION AND OPERATION (Continued)



The pinion gear and shaft is supported by two opposed tapered roller bearings which are assembled in the forward side of the carrier housing. Pinion locating shims, installed between the rear bearing cup and the cup seat, control the drive pinion depth adjustment. The pinion bearing preload is controlled by shims located between the pinion front bearing and the shoulder on the drive pinion shaft.

The differential case assembly is supported by two opposed tapered roller (side) bearings and cups, which are retained in the housing by removable caps. Shims, installed between each differential side bearing and the shoulder on the case, perform three functions: they take up the differential case side clearance; they adjust the backlash between ring gear and pinion; and they establish differential side bearing preload. All Model 60, 70 and 80 Rear Axles have spacers outboard of the differential bearing bore to protect the housing if the bearing cup has spun in the housing.

A cover on the rear of the carrier housing provides access for inspection, removal and installation of the differential assembly and drive pinion. A metal tag, stamped with the gear ratio, part numbers and limited slip (if applicable), is secured to the housing by two of the cover bolts.

The Model 60-1U rear axle has semi-floating axle shafts, meaning the axle shaft supports the load.

The Model 80, 70-1HD, 70-2U and 60-1U rear axles are equipped with full-floating axle shafts, meaning that loads are supported by the axle housing. The axle shafts can be removed without disturbing the wheel bearings, which are opposed tapered roller bearings and are part of the hub assembly.

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DESCRIPTION AND OPERATION (Continued)

The rear hub and rotor assembly on the Model 80 axle is supported or "floats" on the axle spindle on two opposed tapered roller bearings. It is retained on the spindle by a ratcheting nut that is tabbed to a slot on the spindle. If, for any reason, the hub is removed from the spindle, the old hub seal must be removed and a new hub seal installed.

The Dana Model 60, 70, and 80 rear axles have an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of a ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings. Pinion bearing preload is maintained by the pinion nut and selective shims assuring the seating of the inner and outer bearings and cups.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion mate shaft is retained with a threaded bolt lockpin assembled into the differential case.

Functional differences between the semi-float integral rear side assembly and the full-float integral rear axle assembly are as follows:

1. The semi-float axle shafts are retained in the axle by C-washer locks positioned in a slot on the axle shaft splined end. These C-washers also fit into a machined recess in the differential side gears within the differential case.
2. The full-float axle shafts are retained by bolts attached to the hub. The hub rides on two bearings at the outboard end of the axle tube.
3. A semi-float axle shaft rides on one straight-roller bearing at the outboard end.
4. Differential bearing preload and ring gear backlash are adjusted by the use of shims located between the differential bearing cup/races and the carrier housing in the semi- float and the full-float axles.

DIAGNOSIS AND TESTING

Refer to Section 15-01, General Driving Axle and Driveshaft Service. Also refer to Section 18-01 Noise, Vibration and Harshness Diagnosis.

ADJUSTMENTS

For adjustments refer to the specific adjustments in this Section under Disassembly and Assembly and Section 15-01, General Driving Axle and Driveshaft Service.

Refer to Section 11-14 Wheel Hubs and Bearings—for rear wheel bearing adjustment procedures and rear hub specific adjustments.

Refer to Section 12-24 for rear disc brake assembly and/or disassembly procedures for F-Super Duty vehicle Model 80 rear axle usage.

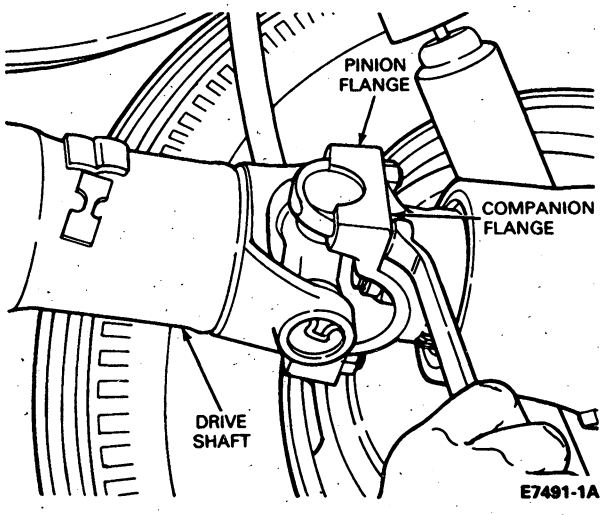
REMOVAL AND INSTALLATION

Drive Pinion Oil Seal

Removal

The drive pinion oil seal can be replaced without removing the axle assembly from the vehicle. Compounded or synthetic rubber seals do not require soaking.

1. Raise the vehicle on a hoist or raise the rear end of the vehicle with a jack. Install safety stands under the frame rails and lower the jack or hoist far enough to allow the axle to drop into the rebound position for working clearance.
2. Remove the nuts and two U-bolts from the rear axle pinion flange and disconnect the driveshaft from the rear axle pinion flange. The Model 80 axle uses straps and bolts which are threaded into the pinion flange. Wire the driveshaft to the frame.

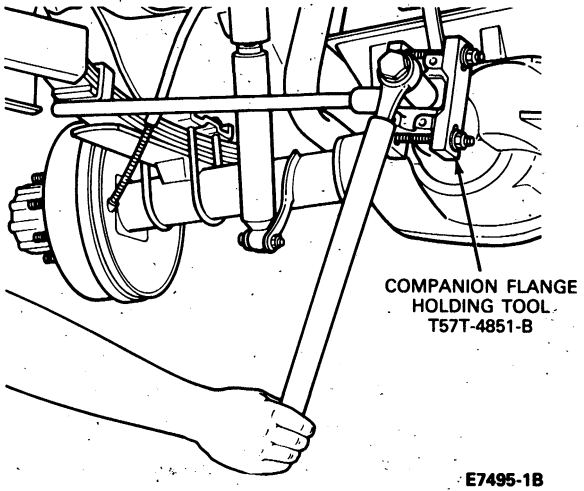


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REMOVAL AND INSTALLATION (Continued)

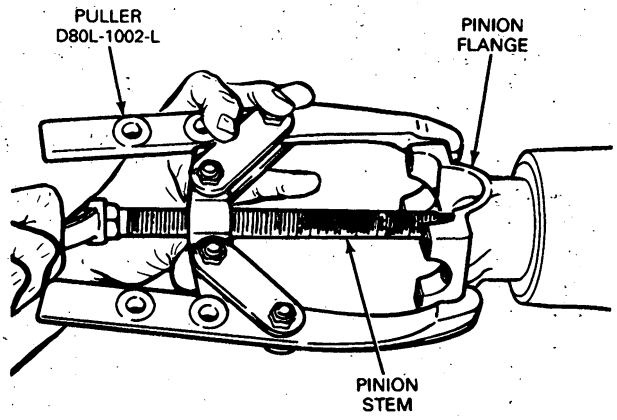
3. Using Tool T57T-4851-B to hold the pinion flange, remove the pinion shaft nut.

NOTE: The Model 80 pinion nut is tightened to 440-500 ft. lb.



E7495-1B

4. Using Tool T65L-4851-B or D80L-1002-L, remove the pinion flange.
5. Using TOOL-1175-AC puller, in combination with Slide Hammer T50T-100A, remove the pinion oil seal.

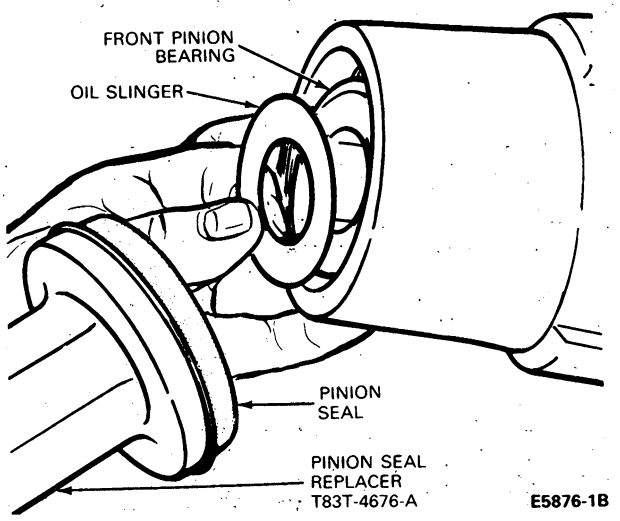


E7494-1A

Installation

1. Clean the pinion oil seal seat. Coat the sealing edge of the new seal with a small amount of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent. Do not put sealer on the sealing lip. Drive the seal into the housing, using Tool T83T-4676-A for Econoline axles. Use Tool T88T-4676-A for F-Super Duty Axles.

CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



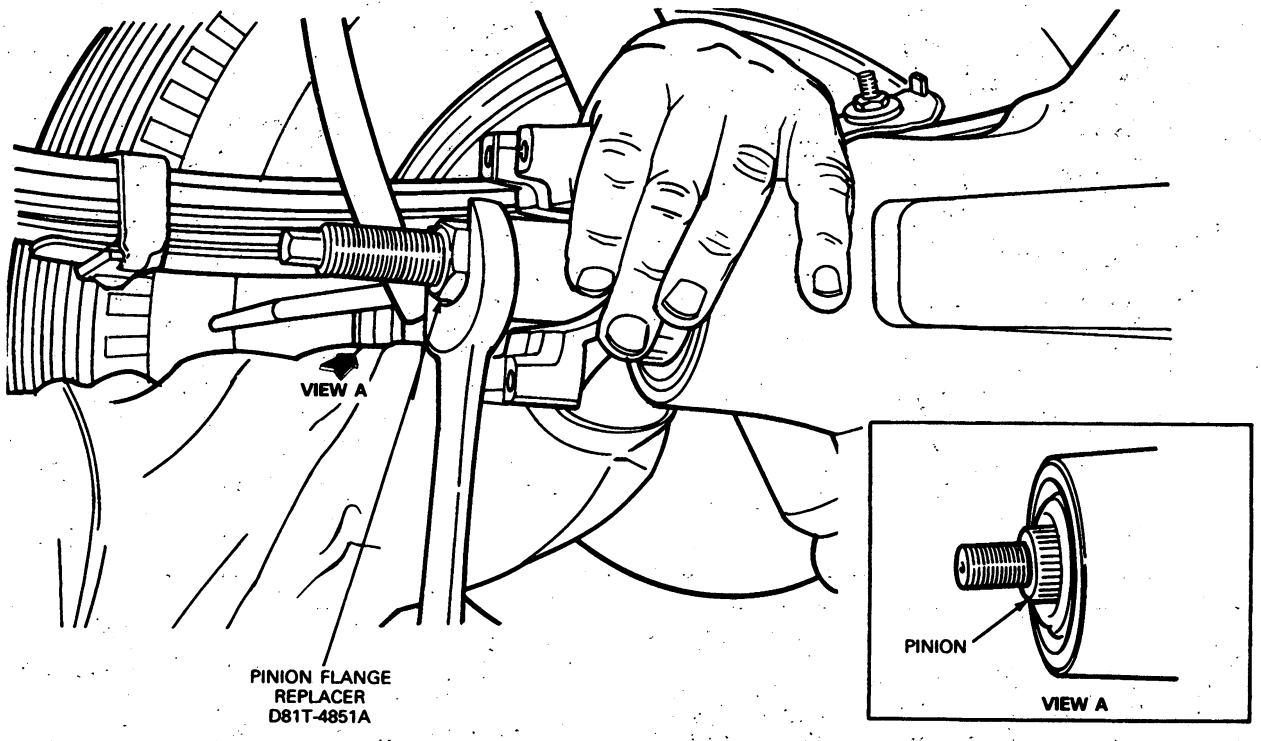
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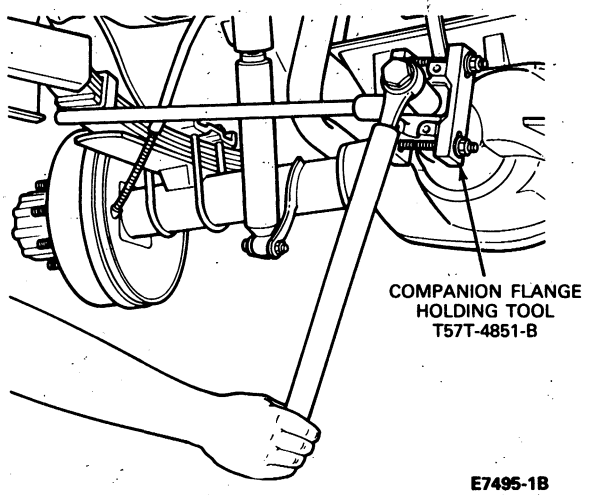
REMOVAL AND INSTALLATION (Continued)

2. Coat the inside of the pinion flange with a small quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent, and install the flange on the pinion shaft, using Tool D81T-4858-A.

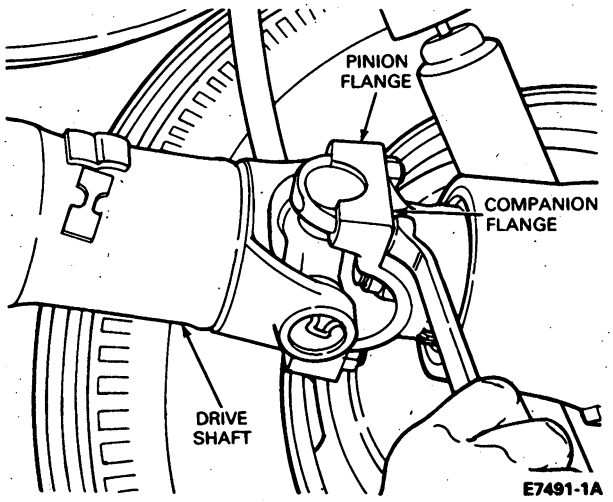
NOTE: The pinion flange must never be hammered on or installed with power tools.



3. Install the pinion attaching nut on the pinion shaft and tighten to specifications listed at the end of this Section. Hold the pinion flange with Tool T57T-4851-B while tightening the nut.



4. Connect the driveshaft to the axle pinion flange, secure with nuts and U-bolts or straps and bolts (F-Super Duty threaded flange) and tighten to specifications listed at the end of this Section.



5. Raise the vehicle, remove the safety stands and then lower the vehicle to road position. Check the level of axle lubricant and add the specified lubricant as necessary.

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REMOVAL AND INSTALLATION (Continued)

Rear Axle

Removal

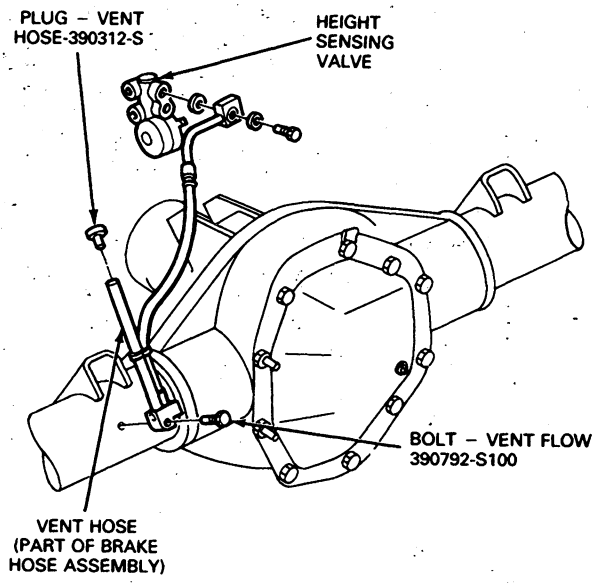
NOTE: Axle shafts, wheel hubs, wheel hub bearings, and the wheel hub grease seals can be replaced without removing the differential assembly from the axle housing or the rear axle assembly from the vehicle.

The axle shafts, wheel hubs, bearings and grease seals may be replaced, lubricated, or adjusted as outlined in Section 11-14, Wheel Hubs and Bearings—Rear (Full Floating Axle).

1. Loosen the wheel stud nuts and the axle shaft to hub retaining bolts.
2. Disconnect the rear shock absorbers from the rear axle, and unclamp the rear stabilizer bar. Then raise the rear end of the vehicle frame until the weight is off the rear springs. Place safety stands under the frame in this position.
3. Disconnect the flexible hydraulic brake line at the frame.
4. Disconnect the parking brake cable (if so equipped) at the equalizer, and remove the cables from the cable support brackets.
5. Disconnect the driveshaft from the rear U-joint flange.
6. Remove the nuts from the rear spring clips (U-bolts), and remove the spring seat caps.
7. Roll the axle from under the vehicle, and drain the lubricant. Remove the wheels. Mount the axle in a work stand. To remove axle shafts, hubs and drums or hub and rotor assemblies refer to Section 11-14, Wheel Hubs and Bearings—Rear (Full Floating Axle).

Installation

1. Apply a coating of Long Life Lubricant, C1AZ-19590-B (ESA-M1C75-BA) or an equivalent lubricant to the lip surface; then, replace the hub inner grease seal. Refer to Section 11-14 for hub and bearing installation (use new axle shaft gaskets); then, install the axle shafts through the housing ends so that they will spline to the differential side gears. Prior to re-installation of the axle shaft, clean and remove any metallic debris in the hub bolt holes. Also inspect for cracked material around the holes, depth of the threaded hole, (minimum 1.0 inch), and oversized threaded holes, and replace hub if any of these three conditions are present. Install **new** shaft retaining bolts (with loctite-type adhesive) and lockwashers.
2. After installing the rear wheels, roll the axle assembly under the vehicle.
3. Install the rear spring clips (U-bolts) and spring seat caps. On Econoline, tighten the nuts to 150-217 N·m (110-160 ft-lbs). Tighten F-Super Duty nuts to 200-270 ft.-lbs (267-360 N·m).
4. Connect the rear shock absorbers, and install the stabilizer bar in position.
5. Connect the drive shaft to the rear universal joint flange. Refer to Section 15-61 for installation instructions and torque specifications.
6. Connect and adjust the parking brake cables (if so equipped). Refer to Section 12-70, Parking Brake.
7. Connect the hydraulic brake hose and bleed the brakes. Also connect the axle vent hose to the axle fitting on Econoline vehicles. The F-Super Duty axle vent hose is part of the brake hose assembly and uses a special "flow" bolt to secure the hose block assembly to the axle.
8. Fill the axle with the proper grade and specified amount of axle lubricant.
9. Lower the vehicle to the floor.



E7493-1A

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REMOVAL AND INSTALLATION (Continued)

Rear Axle Shaft—Semi-Floating Axle

Model 60-1U—Semi-Floating Axle, E-250

Removal

1. Lift vehicle and install safety stands.
2. Remove wheel and brake drum.
3. Drain lubricant from the axle. Remove cover plate to drain lubricant. Clean the gasket material from the cover and axle housing.
4. Remove the differential pinion mate shaft lockscrew as shown in the illustration. Discard lockscrew and replace with new one upon assembly.

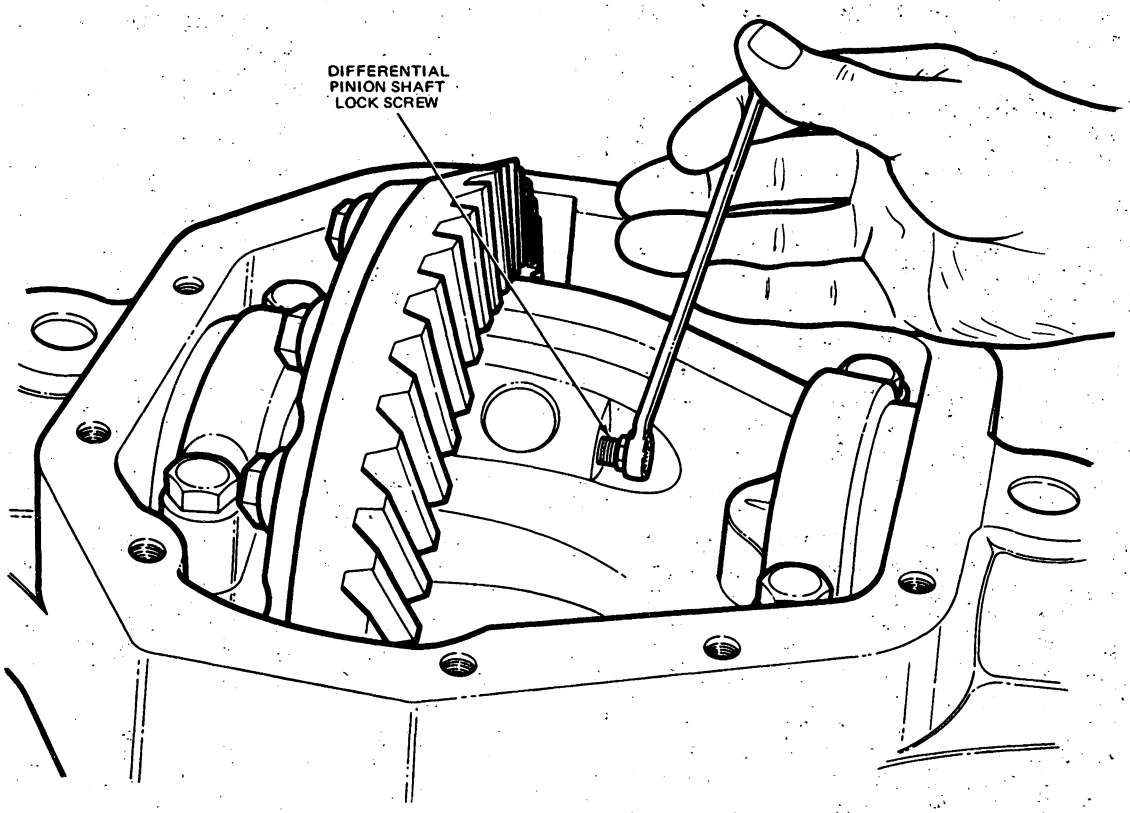
NOTE: It is possible for Dana semi-float axles to be equipped with lockscrew coated with either a Loctite treated thread (or equivalent) or torque prevailing threads. The two types of lockscrew may be identified as follows.

- the Loctite (or equivalent) treated lockscrew have a 5/32 inch hexagram socket head.
- The torque prevailing lockscrew has a 12-point drive head.

If the axle is equipped with a Loctite (or equivalent) treated lockscrew, it must not be re-used under any circumstances.

If the axle is equipped with the torque prevailing lockscrew, it may be re-used up to four times (four removals and installations). When in doubt about the number of times the torque prevailing lockscrew was removed, replace the lockscrew.

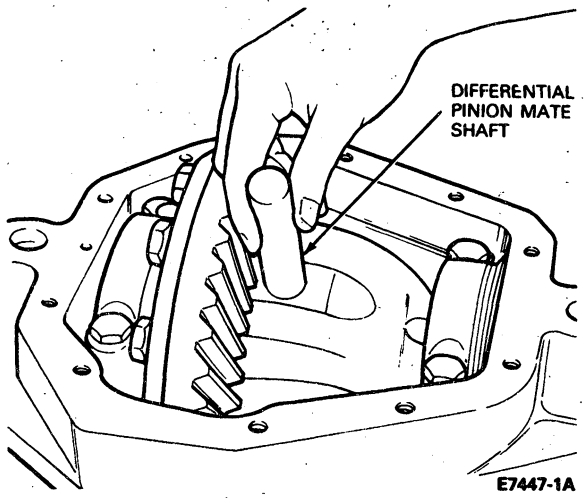
5. Lift out the differential pinion mate shaft as shown. Shaft is a slip-fit design and may be removed by hand.



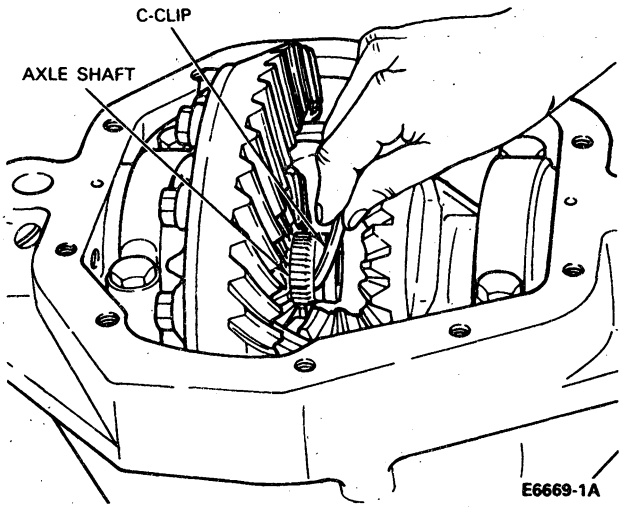
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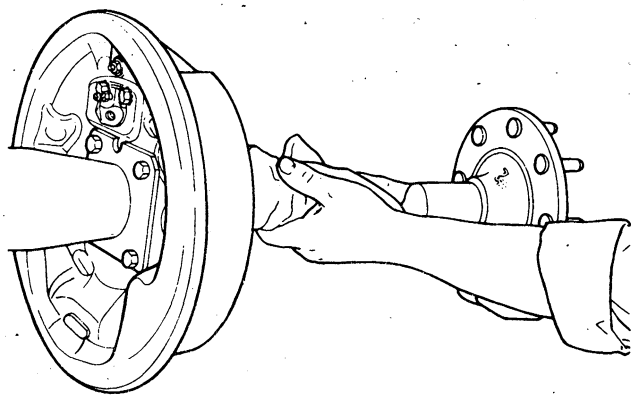
REMOVAL AND INSTALLATION (Continued)



6. Push the flanged end of axle shaft toward the center of the vehicle and remove the C-clip from button end of shaft as shown in the illustration.



7. Pull the axle shaft from the axle tube being careful not to damage oil seals.

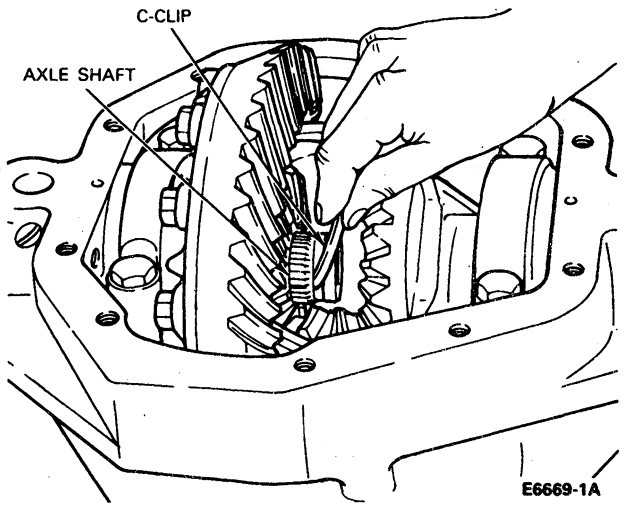


NOTE: When removing axle shafts, do not rotate differential side gears. Rotating side gears causes the pinion mate gears and thrust washers to turn to the differential case opening and fall out.

NOTE: In semi-floating axles, after the axle shafts have been removed, assemble the pinion mate shaft and lockscrew back in the differential case. Use old lockscrew and assemble finger-tight to prevent the side gear and mate gears from rotating and dropping out of the differential case.

Installation

1. Push axle shaft into axle tube, making sure splined shaft end engages side gears. Be careful not to damage oil seals and bearings.
2. Push the flanged end of axle shaft towards center of axle and install C-clip. Pull flanged end outward until C-clip locks into side gear.

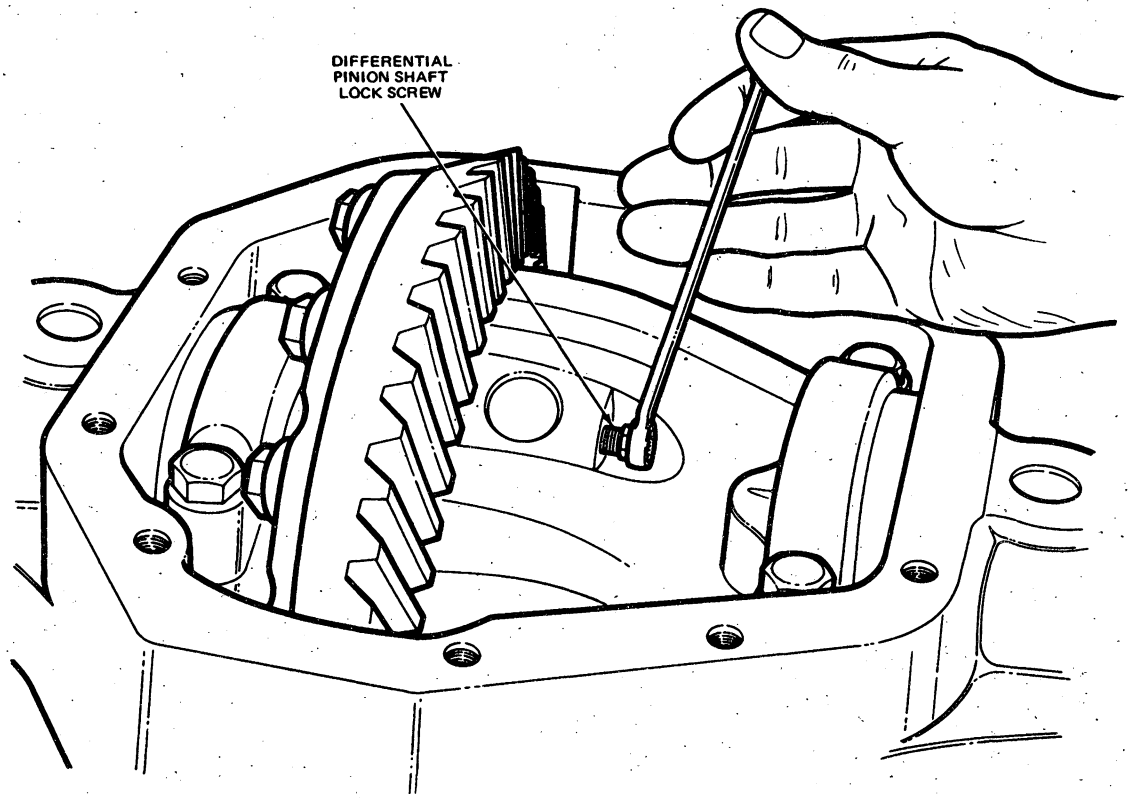


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REMOVAL AND INSTALLATION (Continued)

3. Install pinion mate shaft. Be sure lockscrew hole of the shaft is lined up with the lockscrew hole in case. Be sure pinion gear side washers are in correct position.

4. Install the new lockscrew, making sure the hole in the differential cross shaft is lined up with the screw hole in the case. Make sure the threads in the differential case and on the lockscrew are free of dirt and oil. Tighten lockscrew to 27-34 N·m (20-25 ft-lbs).



E4832-2A

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REMOVAL AND INSTALLATION (Continued)

5. Add RTV or an equivalent sealer to the cover plate. Install cover plate.

A flat mounting surface cover plate is used on all Dana design axles. This cover plate requires the use of a silicone rubber sealer material, Silicon Rubber E7TZ-19562-A (ESL-M4G273A), or equivalent rather than a gasket.

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

CAUTION: Clean both flat surfaces with a suitable solvent to remove all traces of oil film. Sealant material must meet specifications of ESL-M4G273-A, B, ASTM1, GE503, Z1, Z2, Z3 sealant or equivalent.

Apply Silicone Rubber, E7TZ-19562-A (ESL-M4G273-A), or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

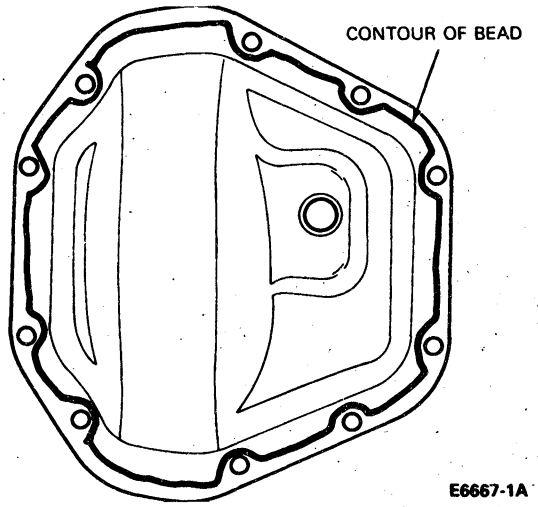
The bead is to be 3.18-6.35mm (1/8-1/4 inch) high and 3.18-6.35mm (1/8-1/4 inch) wide.

- NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.

Assemble two cover screws into cover at 8 o'clock and 2 o'clock position. Use these two holes to guide cover plate into position on the carrier.

Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lbs).

Allow one hour cure time before filling carrier with the proper amount of specified lubricant and vehicle operation.



6. Fill the axle housing with the specified amount of axle lubricant.
7. Install brake drum in position of on axle shaft flange.
8. Install wheel and tire assembly in position to axle shaft flange. Tighten nuts to specifications listed in Section 11-01, General Wheel and Tire Service.
9. Lower vehicle and road test.

Rear Axle Shaft—Full Floating Axle

Models 60-1U 70-2U and 80—E-350 DRW, F-Super Duty series vehicles for removal and installation of rear axle shafts. Refer to Section 11-14, Wheel Hubs and Bearings—Rear Dana Full Floating Axle.

Oil Seal and Wheel Bearing—Semi-Floating Axle

Model 60-1U Semi-Floating Axle

E-250

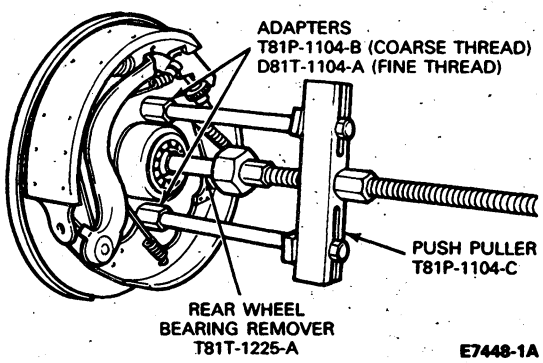
Removal

1. Remove axle shaft as described in this Section.
2. Remove the oil seal from the axle tube. Discard the seal.
3. Pull the bearing from the axle tube using Push Puller T81P-1104-C, Adapters T81P-1104-B (coarse thread) or D81T-1104-A (fine thread) and Rear Wheel Bearing Remover, T81T-1225-A, as shown.

CAUTION: Wear safety glasses when removing the bearing in the event the bearing explodes or shatters during removal.

4. Use a standard metal cleaning solvent to clean out the bearing bore in the housing. Wipe this area clean, making sure it is free from dirt or any other contamination that might be present.

NOTE: The bearing bore must be free from nicks and burrs. Wipe the bore with emery cloth to assure a smooth surface. Clean bore out with a standard metal cleaning solvent. If bore has burrs or spalled areas and a new bearing is installed, it may lead to early fatiguing.



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REMOVAL AND INSTALLATION (Continued)

Installation

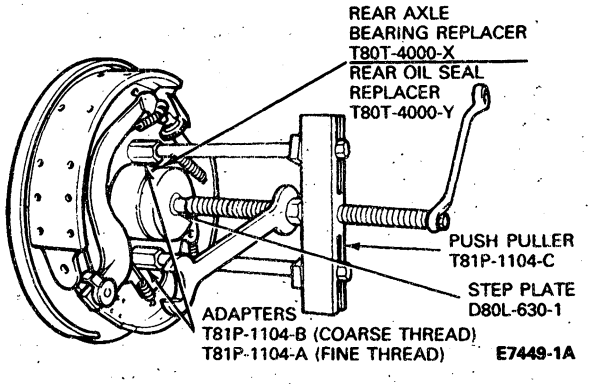
1. Coat the bearing with differential lube for easier assembly and to prevent possible scoring of the tube bore.
2. Install bearing in the tube bore using Push-Puller T81P-1104-C, Adapters T81P-1104-B or D81T-1104-A, Step Plate D80L-630-1 and Rear Axle Bearing Replacer T80T-4000-X.

NOTE: When installing bearing make sure the bearing is not cocked in the bore during installation.

3. Install a new oil seal in the bore using Push Puller T81P-1104-C, Adapters T81P-1104-B or D81T-1104-A, Step Plate D80L-630-1 and Rear Oil Seal Replacer T80T-4000-Y, as shown. An alternate method of installing the seal is to drive the seal into place with Rear Oil Seal Replacer T80T-4000-Y and Driver Handle, T80T-4000-W.

NOTE: Make sure the seal is not cocked in the bore during installation.

4. Lubricate cavity between seal lips and bearing with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B).
5. Install axle shafts as described in this Section.



Oil Seal and Wheel Bearing—Full Floating Axle

Model 60-1U, 70-2U, 80 Full Floating Axle

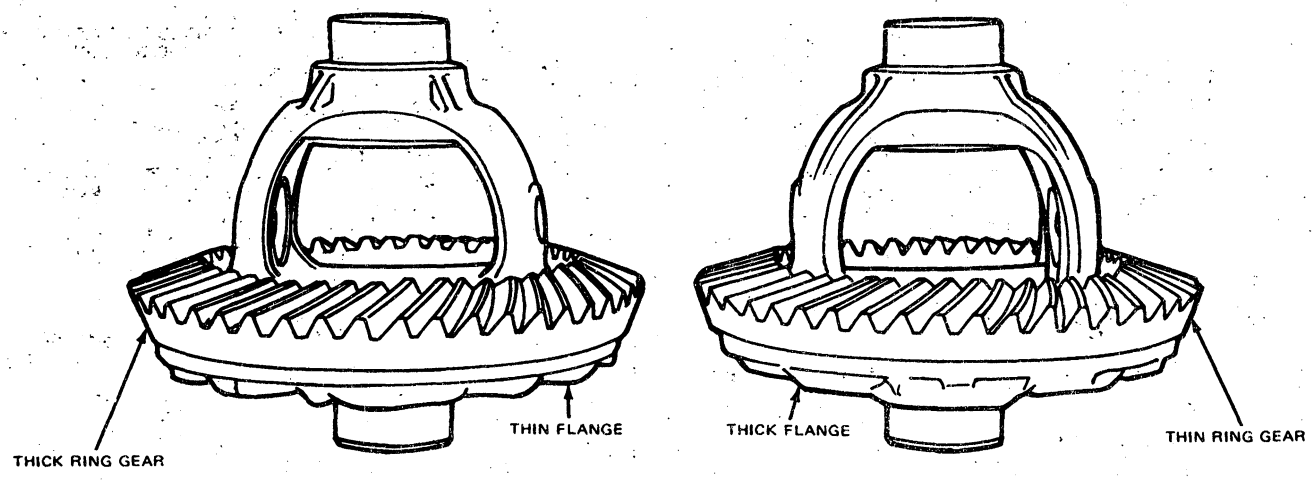
Removal and Installation

Refer to Section 11-14, Wheels, Hubs and Bearings (Full Floating Axle) for removal and installation procedures.

DISASSEMBLY

NOTE: When changing ratios on the Model 60 and Model 70 Series rear axles, it may be necessary to change the differential case along with the ring gear and drive pinion.

In the 60-1U, and 70 Series axles, ratios '3.54 to 1' up to '4.10 to 1' incorporate a thick differential case flange and a thin ring gear. Ratios '4.56 to 1' and up incorporate a thin differential case flange and a thick ring gear.



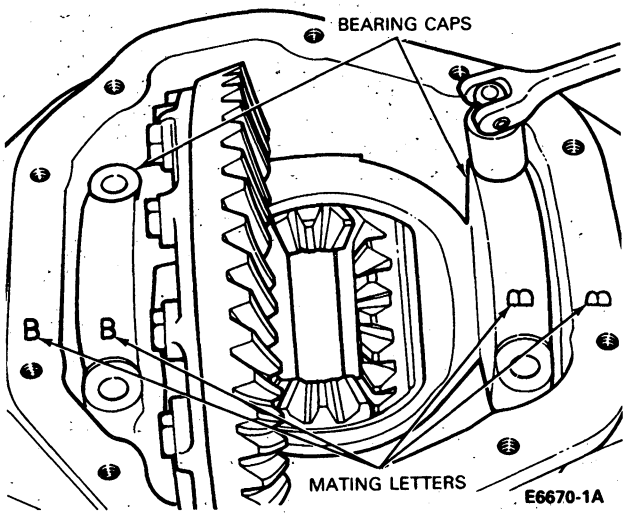
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DISASSEMBLY (Continued)

Disassembly

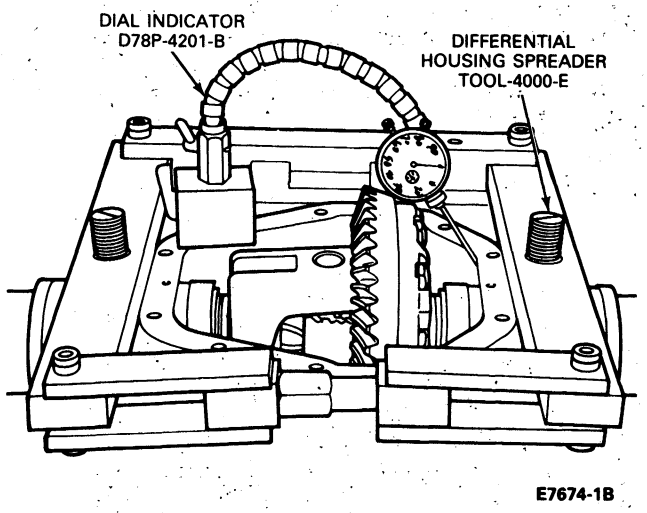
1. Remove the rear axle from the vehicle as outlined in Removal and Installation.
2. Remove cover plate and drain lubricant from axle. The lube will drain out as the cover plate is removed.
3. Remove cover plate screws, and cover plate. Tip carrier to allow lube to drain completely. Also during this time clean the cover face of the carrier, making sure it is free from any nicks and remove old RTV gasket material.
4. Remove bearing caps.

NOTE: Mating letters are stamped on caps and carrier. This is important at time of assembly as they are to be assembled exactly as removed. Letters are in vertical and horizontal positions.

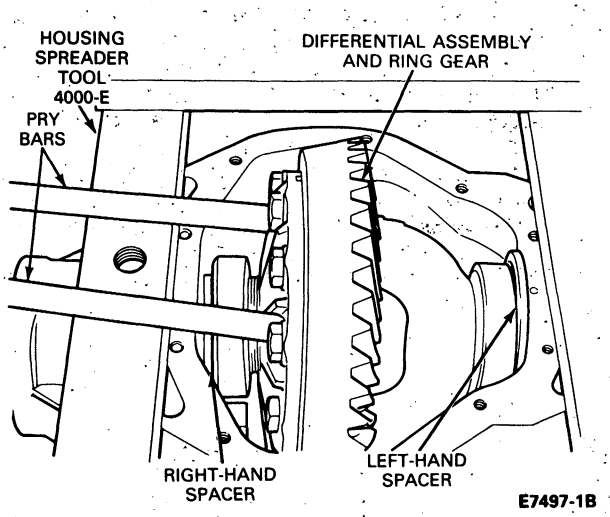


CAUTION: Before removing differential case and ring gear, make sure the axle shafts are pulled out far enough for clearance to remove differential. Refer to Section of manual covering the type of axle assembly being serviced.

5. Place Differential Housing Spreader, on the case. Install Dial Indicator, Tool D78P-4201-B on the carrier housing. Do not spread housing more than 0.38mm (0.015 inch).



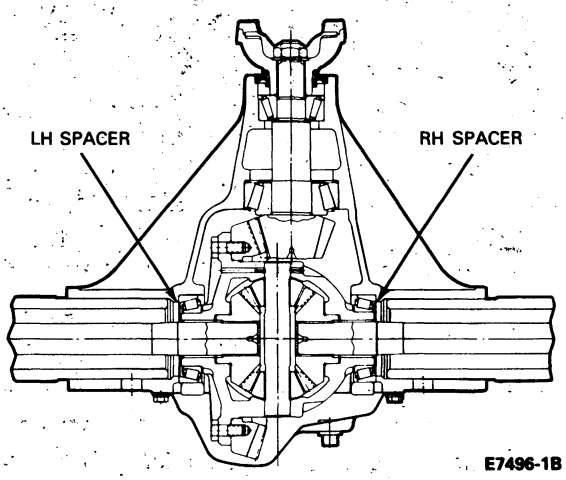
6. Pry differential case from carrier with two pry bars. After differential case has been removed, remove spreader. Use caution to avoid damage to ring and pinion. Mark or tag bearing cups indicating from which side they were removed.



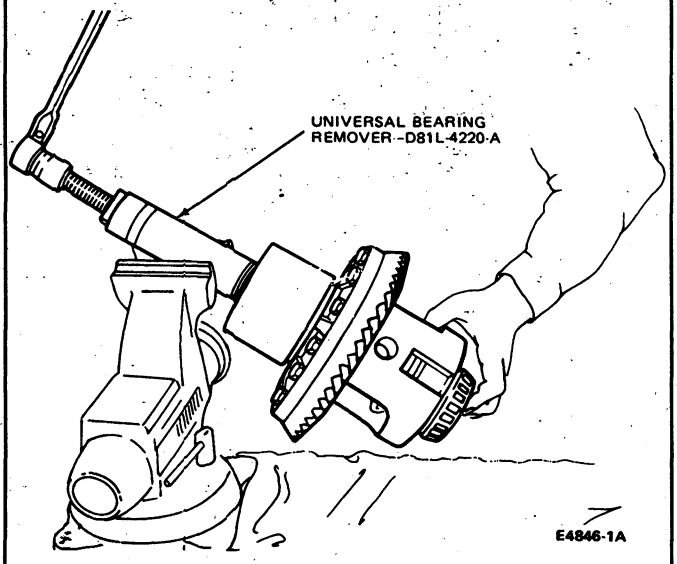
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DISASSEMBLY (Continued)

Dana Model 60, 70 and 80 rear axles incorporate spacers installed outboard of each differential bearing cup. Remove both spacers and tag each indicating the side each was removed from. Inspect both spacers for damage, bent or grooved conditions. Replace if required.

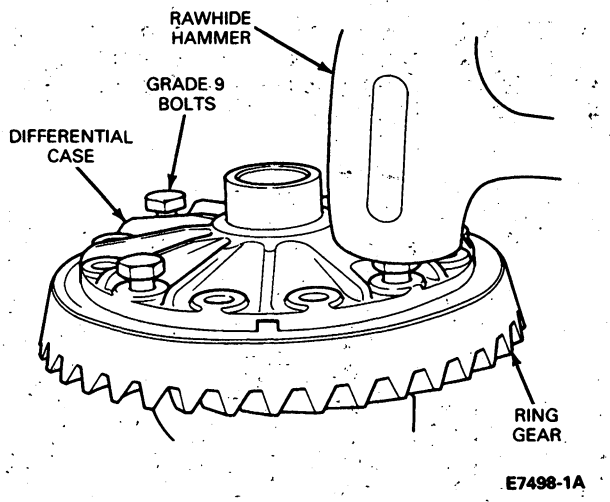


7. Remove differential bearings with special tool, Universal Bearing Remover D81L-4220-A. Place the tool in a vise when removing bearing. Wire shims, bearing cup, bearing cone, and outboard spacer together. Identify from which side they were removed. (Ring gear side or opposite side). If shims are damaged, replace with new ones at time of assembly. Shims are available in thicknesses of mm .08, .13, .25, and .76 (.003 inch, .005 inch, .010 inch, and .030 inch). Reposition case in puller and remove other bearing cone as described above. Replace bearings whenever they are removed from the carrier.

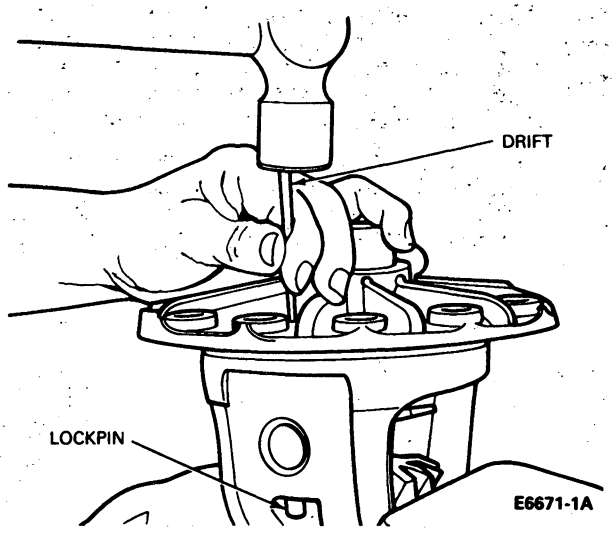


8. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked. Place case in vise. Remove ring gear bolts. Leave four bolts loosely assembled 90 degrees apart. Tap each bolt head alternately with a rawhide hammer to loosen the ring gear. Remove bolts and ring gear.

NOTE: Whenever removing the ring gear bolts, always replace with new bolts upon assembly. Use grade 9 bolts for service replacement for all Dana axles.



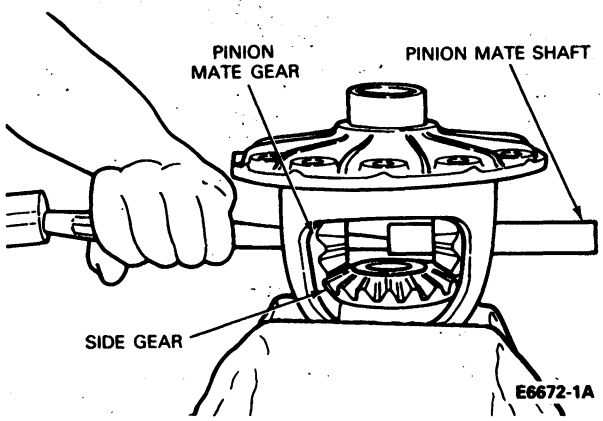
9. Replace case in vise and drive out lock pin which secures the pinion mate shaft. Use a small drift as shown.



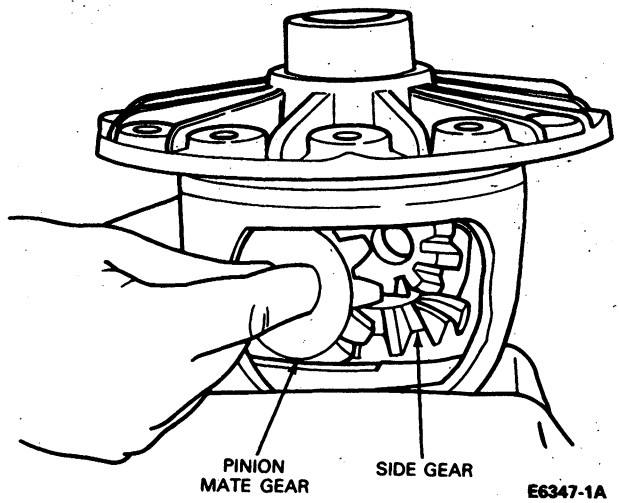
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DISASSEMBLY (Continued)

10. Remove pinion mate shaft with drift as shown.

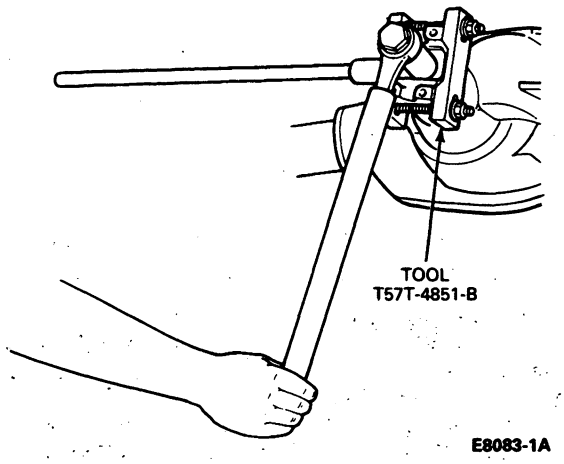


11. To remove side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case. Remove pinion mate gears and also the spherical washers behind the gears. Lift out side gears and thrust washers. Inspect all parts, including the machined surfaces of the case itself. If excessive wear is visible on all parts, it is suggested that the complete differential assembly be replaced. If any one of the gears are to be replaced, THEY ARE TO BE REPLACED AS A SET.

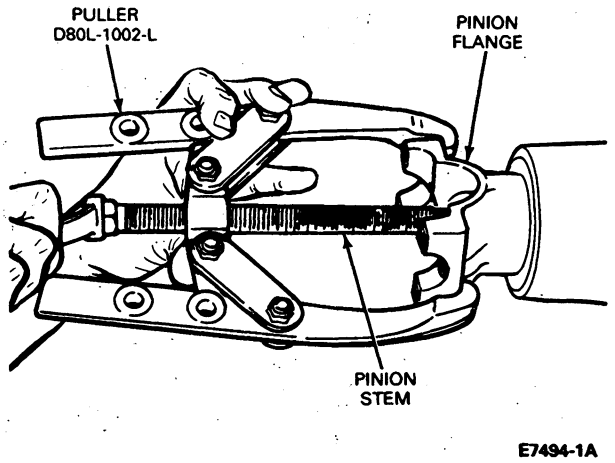


12. Turn nose of carrier in a horizontal position, remove pinion nut. Hold pinion flange with Tool T57T-4851-B Companion Flange Holding Tool, and remove pinion nut and washer.

NOTE: Pinion nut for Model 80 axle requires 596-678 N·m (440-500 ft-lbs.) of torque to remove.



13. Remove pinion flange with Tool-D80L-1002-L. If the pinion flange shows wear in the area of the seal contact, it should be replaced.

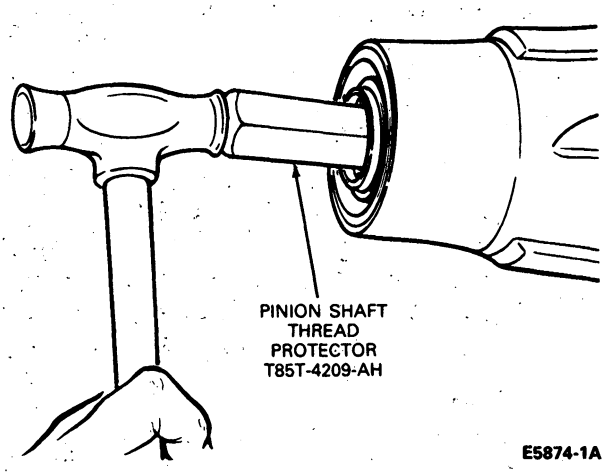


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DISASSEMBLY (Continued)

14. Remove pinion by tapping with a rawhide hammer. Catch the pinion with your hand to prevent it from falling and being damaged.

CAUTION: Handle pinion gear carefully to prevent injury.



E5874-1A

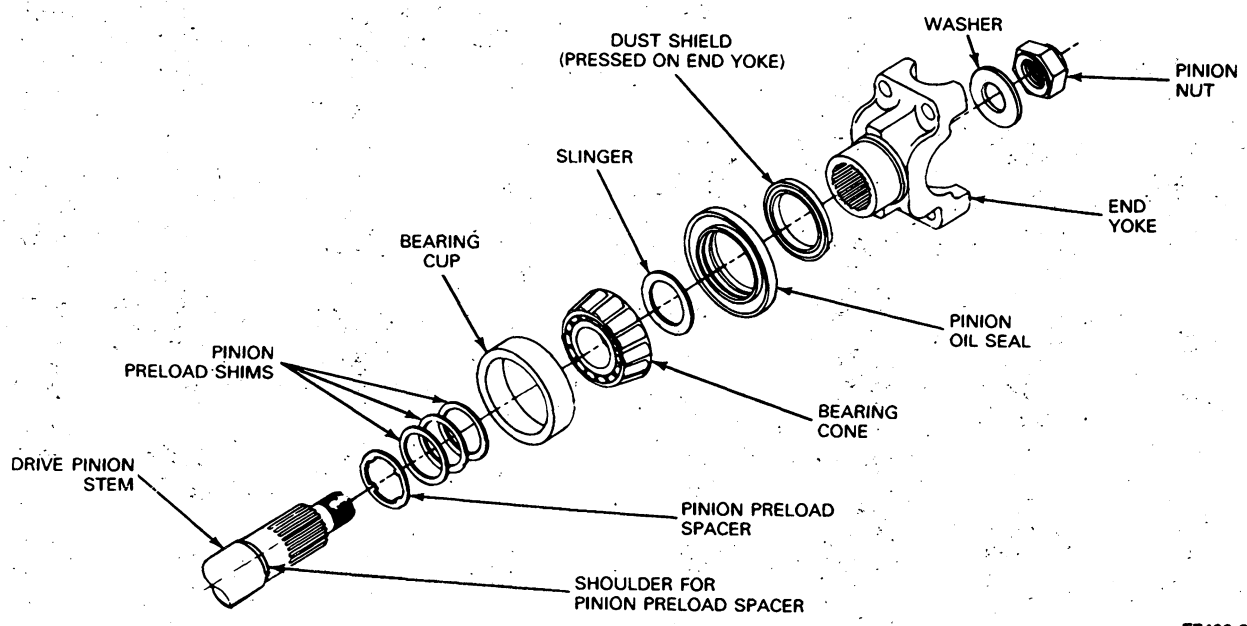
NOTE: On the spline end of the pinion, there are bearing preload shims. These shims may stick to the pinion or bearing or even fall out. These shims are to be collected and kept together since they will be used later in assembly. Try not to damage shims. If shims are damaged, replace with new ones. Shims are available in thicknesses of mm .08, .13, .25, and .76 (.003 inch, .005 inch, .010 inch, and .030 inch).

Model 70 axle may also include a pinion bearing preload spacer with the inner pinion bearing preload shims.

The illustration shows the assembly sequence for the drive pinion preload spacer that is included in the service kit and must be used with the drive pinion kit.

The drive pinion preload spacer and preload shims assembly sequence must be followed. If sequence is not followed and components are improperly assembled, it may cause unit failure.

Axle assemblies manufactured without and prior to the use of the pinion preload spacer may be serviced with this drive pinion and preload spacer.

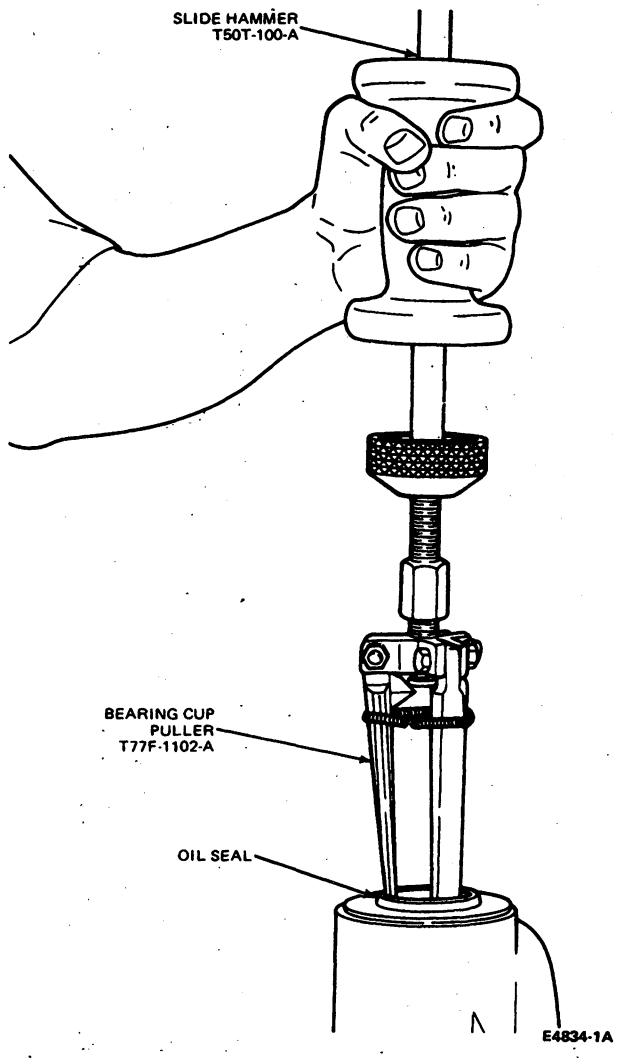


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DISASSEMBLY (Continued)

15. Pull out pinion seal with Puller T77F-1102-A, Bearing Cup Puller and T50T-100-A, Slide Hammer (Fig. 15). Discard seal. REPLACE WITH NEW ONE AT TIME OF ASSEMBLY. Remove bearing cone and outer oil slinger.



16. Turn nose of carrier down. Remove outer pinion bearing cup with Driver Handle D81L-4000-A and the correct size bearing cup remover as shown in the following illustration.

CAUTION: Do not nick carrier bore.

NOTE: The front and rear carrier section may vary in pinion bore depth due to the possibility of the need for either a baffle or slinger or both.

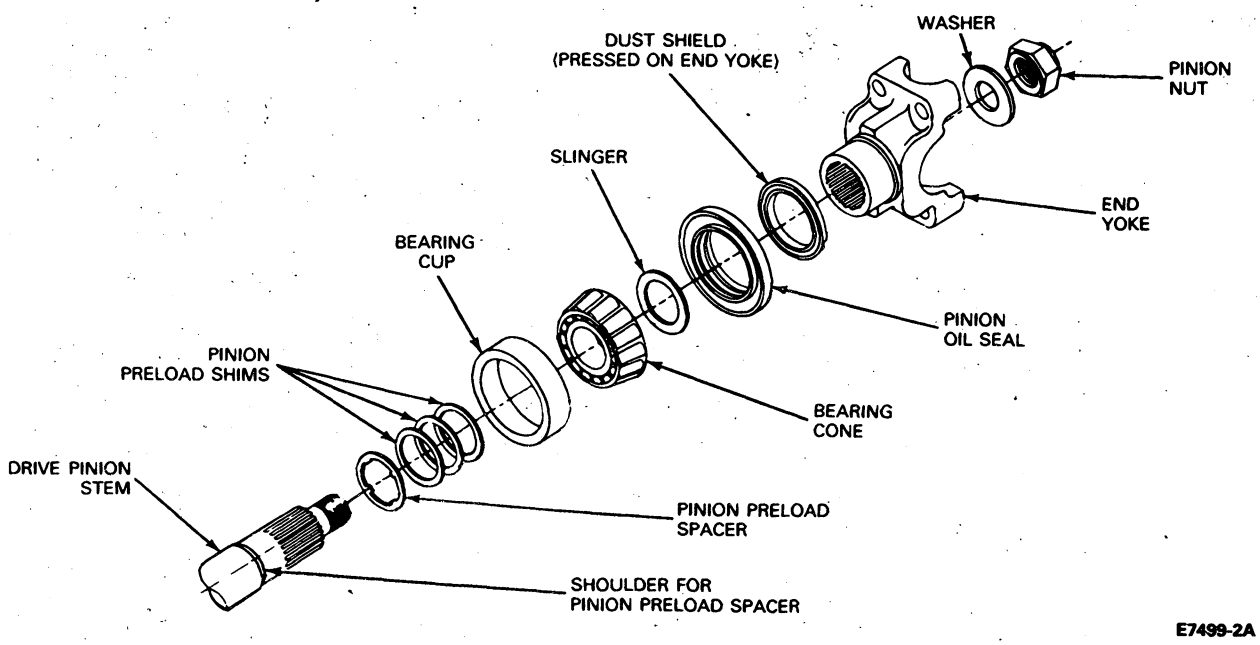
The baffle serves the same purpose as a dam, to assure that the pinion bearings are maintained with lubricant.

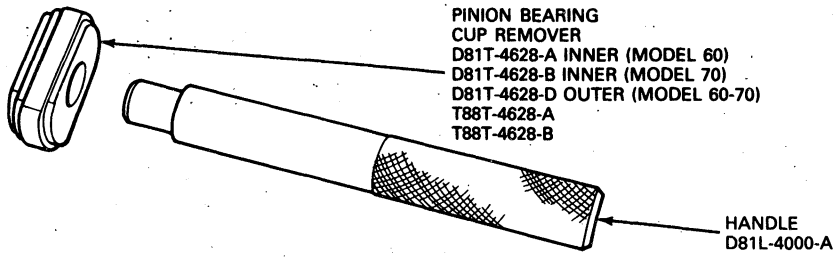
The slinger serves the purpose of assisting the lube to flow up through the oil channels to lubricate the pinion bearings. If used, they are part of the pinion setting adjustment.

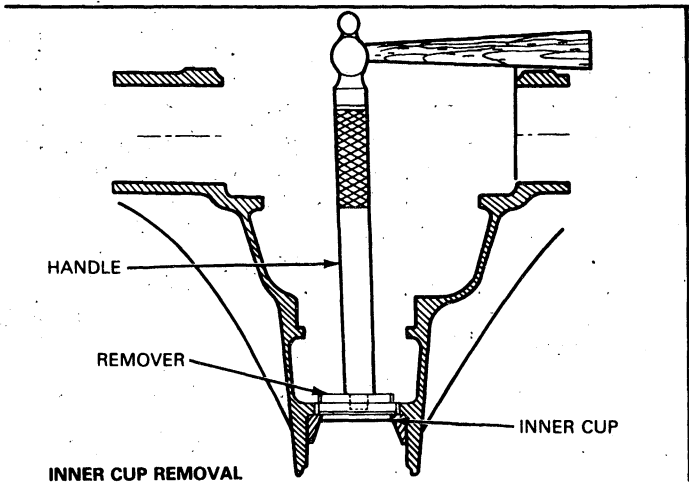
17. Remove the inner bearing cup with Driver Handle D81L-4000-A and the correct size bearing cup remover as shown in the following illustration.

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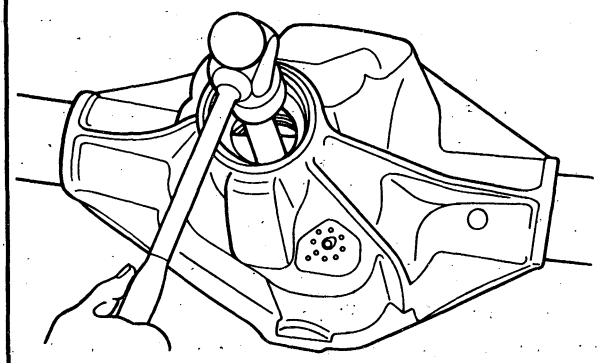
DISASSEMBLY (Continued)







INNER CUP REMOVAL



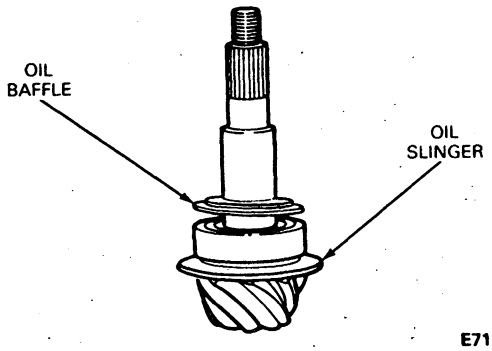
OUTER CUP REMOVAL

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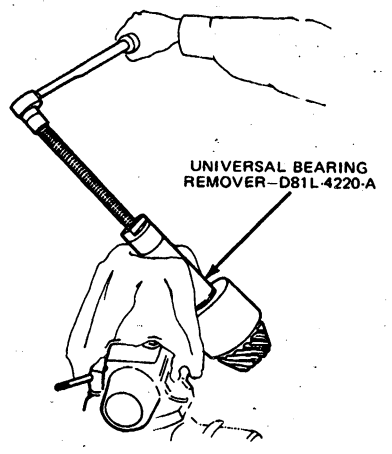
DISASSEMBLY (Continued)

NOTE: Shims are located between the bearing cup and carrier bore and may also include an oil baffle. If shims and baffles are bent or nicked, they should be replaced at time of assembly. Wire shim stacks together and measure each. If stack has to be replaced, replace with same thickness shim pack.



18. Remove bearing from pinion with Universal Bearing Remover, D81L-4220-A.

NOTE: Both baffle and slinger are part of the pinion adjustment shims and are to be kept intact for assembly.



2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.
4. Set up dial indicator Tool D78P-4201-B and check ring gear and pinion backlash and ring gear backface runout.

Check ring gear and pinion backlash in three equally spaced points with dial indicator.

Backlash tolerance is 0.127-0.203mm (0.005-0.008 in) and cannot vary more than 0.05mm (0.002 in) between points checked.

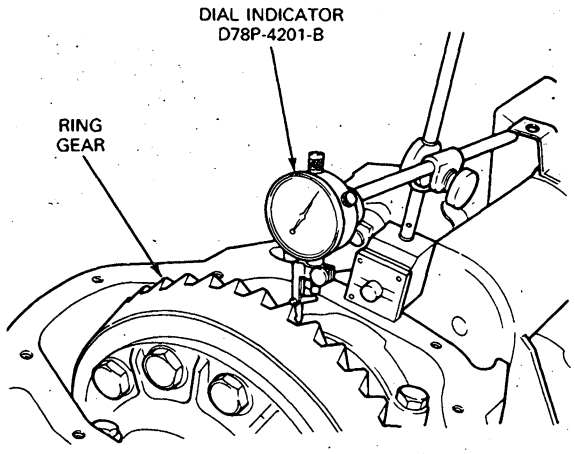
High backlash is corrected by moving the ring gear away from the pinion.

Low backlash is corrected by moving the ring gear away from the pinion.

These corrections are made by switching shims from one side of the differential case to the other.

To check ring gear backface runout, mount Dial Indicator D78P-4201-B on the carrier so the tip of the dial indicator contacts the backface of the ring gear. Backface runout should be no more than 0.101mm (0.004 inch).

5. A contact pattern is not an acceptable guide to check for noise. Proper gear set assembly must be checked using the Rear Axle Pinion Depth Gauge Tool set which shows the correct pinion depth required to assure acceptable running condition. See Section on Drive Pinion and Gear Set.



CLEANING AND INSPECTION

Inspection Before Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the axle assembly. These inspections can find the cause of the concern and determine the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.

Inspection After Disassembly

Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air. Oil the bearings immediately to prevent rusting. Inspect the parts for any major damage. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.

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CLEANING AND INSPECTION (Continued)

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.0381mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be re-seated.

Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for stop wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Pinion Flange

Be sure that the flange half-rounds and lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

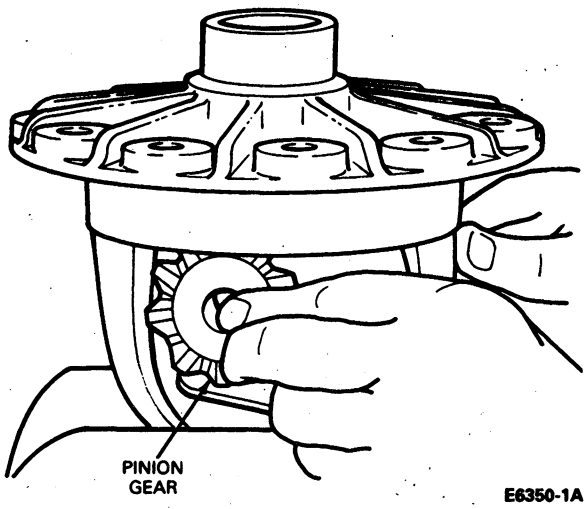
Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

ASSEMBLY

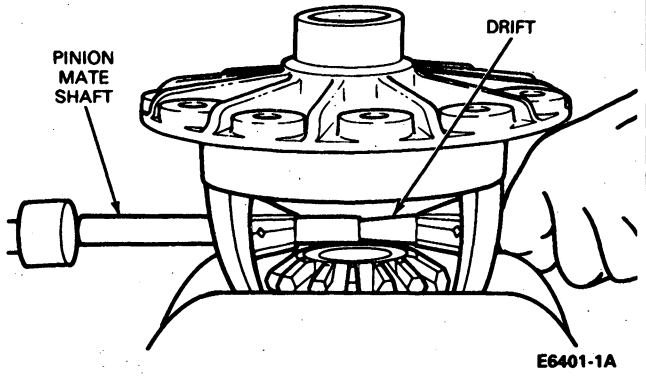
Differential Case

Assembly

1. Place differential case in vise. Apply grease, Long Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, to new side gear thrust washers and to hubs and thrust face of the new side gears. Install both side gears. Apply grease to the new pinion mate spherical washers and the new pinion mate gears.
2. Assemble both side gears and thrust washers, hold in place with hand, then assemble the pinion mate gears and washers to hold the side gears in place. An easy way to assemble the side gears and pinion mate gears is to have all parts lubricated with Rear Axle Lubricant C6AZ-19580-E (ESW-M2C105-A) before assembly.
3. Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shaft.



4. Use a drift to line up the holes with those of the differential case.
5. Assemble pinion mate shaft, drive on shaft to remove drift. Be sure lock pin hole of the shaft is lined up with the lock pin hole of the case.

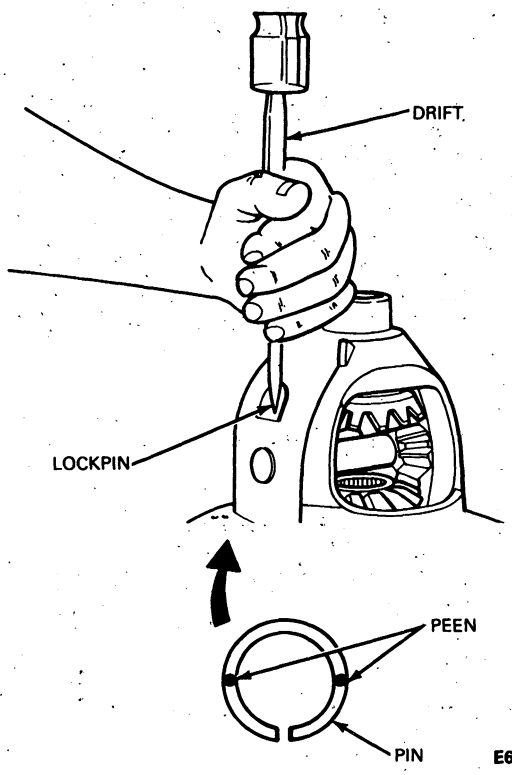


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ASSEMBLY (Continued)

6. Assemble lock pin. Peen metal of case over pin in two places 180° apart to lock in place. Note the location of the slot in the lockpin and peen 90° away.

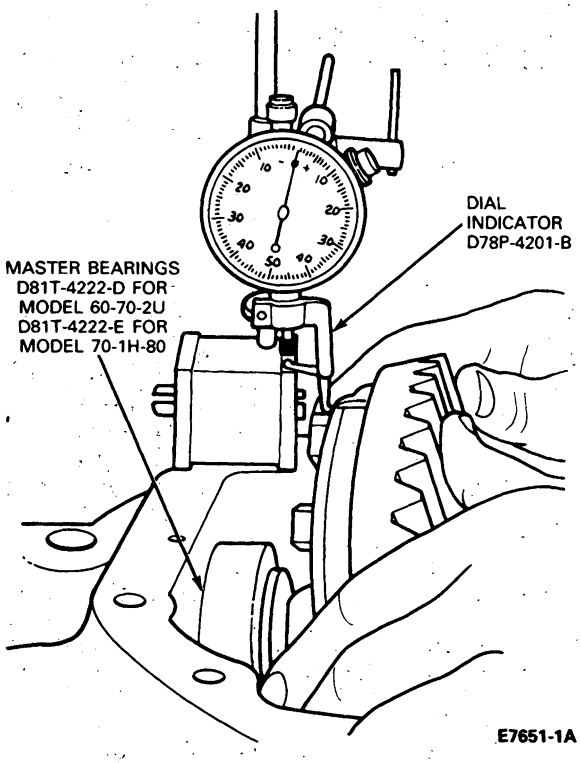
NOTE: The semi-float shaft riding bearing design uses a lock pin that is assembled with the use of a 12 point socket wrench. Use a new lock pin and assemble finger tight only. This procedure is necessary to prevent differential side gears and differential pinion mate gears from rotating in the case and dropping out when servicing the carrier section. A new lock pin should be installed after assembling the axle shafts.



E6402-1B

7. Be sure flange face of the case is free of nicks or burrs. Assemble ring gear to case. Line up holes of the ring gear with those of the case. Use new ring gear bolts. Draw up gear bolts alternately and evenly. Tighten ring gear bolts to 136-163 N·m (100-120 ft-lbs) for grade 8 bolts. Tighten grade 9 bolts 169-183 N·m (125-135 ft-lbs) for Model 60, 61, 70 axles. Tighten Model 80 ring gear bolts to 285-312 N·m (210-230 ft-lbs).
8. Install Master Differential Bearings, Tool D81T-4222-D for Model 60 and 70-2U axles. Use Tool D81T-4222-E for 70-HD and Model 80 axles onto the differential case. Remove all nicks, burrs, dirt, etc., from hubs to allow bearings to rotate freely.
9. Assemble differential case into carrier (less pinion). Mount dial indicator with a magnetic base Tool D78P-4201-B as shown. Locate tip of indicator on flat surface of one of the ring gear screw spot faces. Force differential assembly as far as possible in the direction towards the indicator. With force still applied, set indicator at zero (0).

NOTE: Dial indicator should have a minimum travel of 5.08mm (0.200 inch).



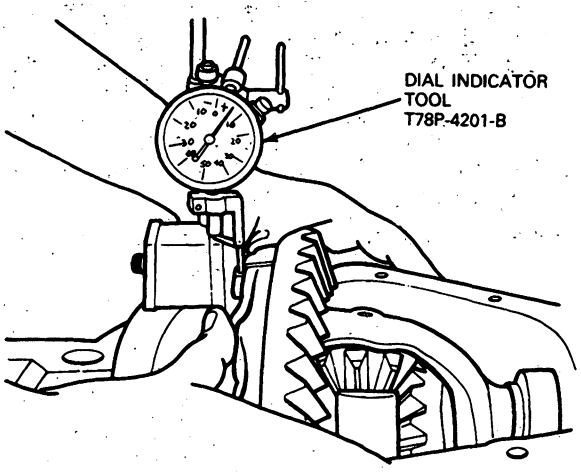
E7651-1A

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ASSEMBLY (Continued)

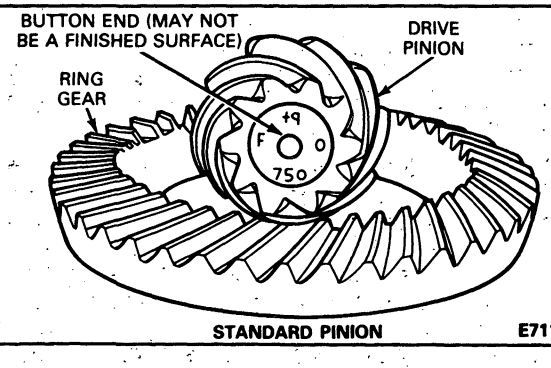
10. Force the differential assembly as far as it will go in the opposite direction. Repeat these steps until you have obtained the same reading. Record the reading of the indicator. This will be the total amount of shims required (less preload) and will be calculated later during assembly. After making sure the readings are correct, remove indicator and differential assembly from housing. DO NOT REMOVE MASTER BEARINGS FROM DIFFERENTIAL CASE AT THIS TIME.

This reading is the Total Differential Case Endplay which will be needed in Step 6 of Assembly of Differential into Housing later in this Section.



E7652-1A

11. Ring gears and pinions are supplied in matched sets only. Matching numbers on both the pinion and ring gear are etched for verification. If a new gearset is being used, verify the numbers of each pinion and ring gear before proceeding with assembly. The end of the pinion with the etched figures shown is known as the "button" end. The surface with the etched figures may or may not be a precision ground surface, which is necessary for use of the final chock gauge block with the pinion. If the surface is not precision ground, the tooth combination information stamped on the pinion stem between the bearing diameters will have the letter "B" following. Examples: 46-13B, 41-11B, and 41-10B are not finish ground and may not utilize the final check gauge block.

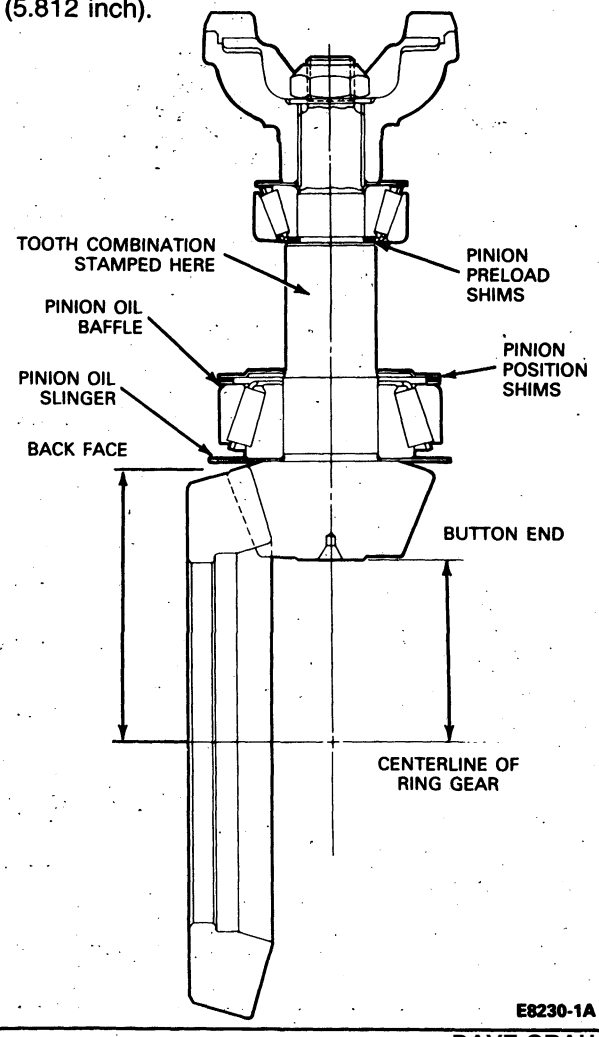


STANDARD PINION E7117-1B

The distance from the centerline of the ring gear to the button end of the pinion for the Models 60-1U, is 79.37mm (3.125) inch. For Model 70 and 80, the distance is 88.9mm (3.50 inch).

On the button end of each pinion, there is etched a plus (+) number, a minus (-) number, or a zero (0) number which indicates the best running position for each particular gear set. This dimension is controlled by the shimming behind the inner pinion bearing cup (the backface).

The difference from the centerline of the ring gear to the backface of the pinion for Model 60-1U is 127mm (5.000 inch) for Model 70-2U, the distance is 136mm (5.375 inch) and for Model 80 is 148mm (5.812 inch).



E8230-1A

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ASSEMBLY (Continued)

For example—If a pinion is etched a plus m+8 (+3), this pinion would require .08mm (.003 inch) less shims than a pinion etched "0". This means by removing shims, the mounting distance of the pinion is increased to 98.45mm (3.128 inch), which is just what a m+8 (+3) indicates. Or if a pinion is etched m-8 (-3), we would want to add .08mm (.003 inch) more shims than would be required if the pinion were etched "0". By adding .08mm (.003 inch) shims, the mounting distance of the pinion was decreased to 98.29mm (3.122 inch) which is just what a m-8 (-3) indicated.

If the old ring and pinion set is to be reused, measure the old shim pack and build a new shim pack to this same dimension. If a baffle is used in the axle assembly, it is considered as part of the shim pack.

To change the pinion adjustment, shims are available in thicknesses of mm .08, .13, and .25 (.003 inch, .005 inch, and .010 inch).

NOTE: If baffle or slinger is bent or mutilated, it should be replaced.

Measure each shim separately with a micrometer and add together to get the total shim pack thickness from the original build up.

If a new gear set is being used, notice the (+) or (-) etching on both the old and new pinion and adjust the thickness of the new shim pack to compensate for the difference of these two figures.

For example—If the old pinion reads m+5 (+2) and the new pinion is m-5 (-2), add .10mm (.004 inch) shims to the original shim pack.

SHIM SELECTION CHART — INCHES

Old Pinion Marking	New Pinion Marking								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

SHIM SELECTION CHART — METRIC

Old Pinion Marketing	New Pinion Marking								
	−10	−8	−5	−3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05
+3	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08
0	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10
−3	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13
−5	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15
−8	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18
−10	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18	−.20

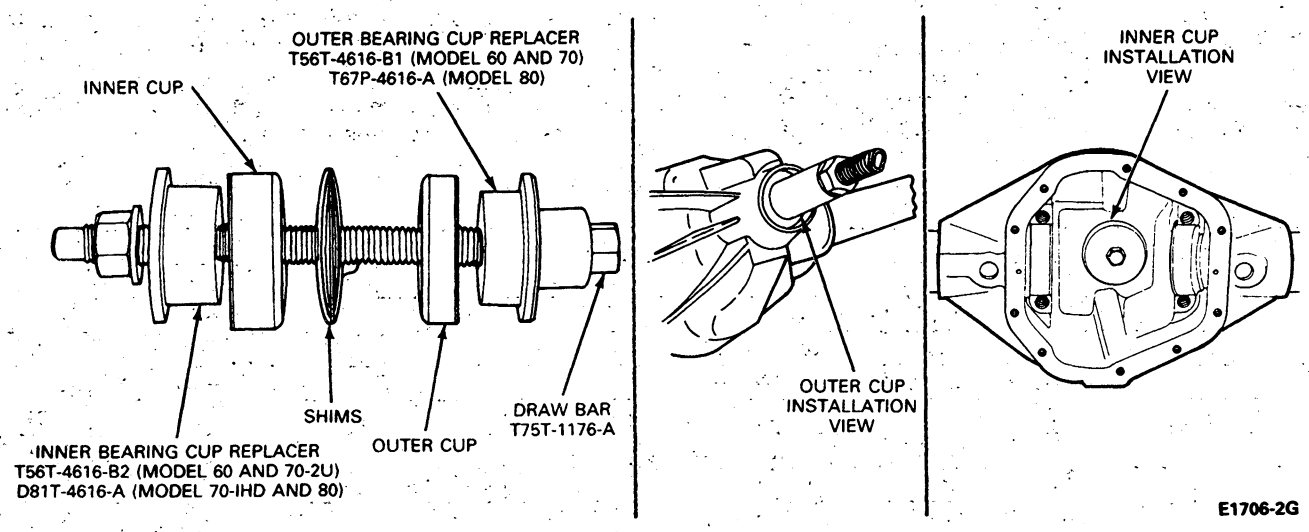
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ASSEMBLY (Continued)

Pinion Bearing Cup Installation

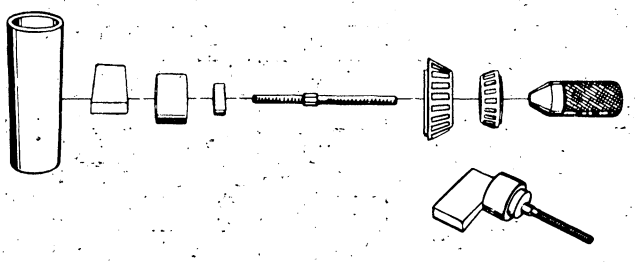
1. Place the required amount of preload shims under the inner cup as shown.
2. Place the inner and outer bearing cups into the carrier bore.
3. Place the Inner Bearing Cup Replacer Tool on the inner bearing cup. For Model 60 and 70-2U axles, use T56T-4616-B2. For Model 70-1HD and 80 axles, use D81T-4616-A.
4. Place the Outer Bearing Cup Replacer Tool on the outer bearing cup. For Model 60 and 70 use T56T-4616-B1. For Model 80 axles, use T67P-4616-A.
5. Install the Threaded Drawbar, T75T-1176-A into the replacer tools and tighten the drawbar to install the cups into the carrier bore.



Depth Gauge Check

1. Refer to the following tool usage chart for the correct tools for the particular axles. Tool T80T-4020-A

NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure no erroneous readings.



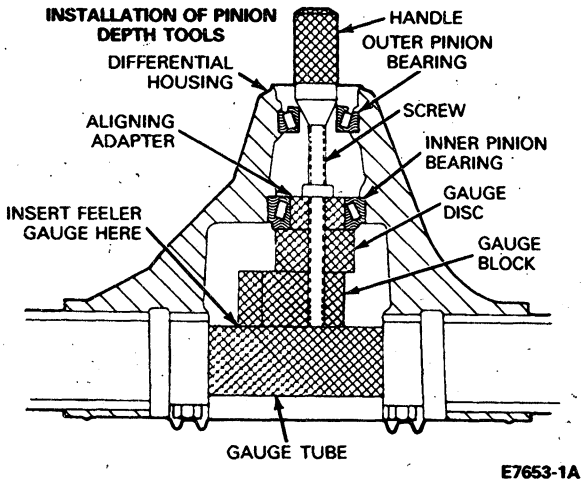
Description	Number	Model 60	Model 1HD	Model 70-2u	Model 80
Handle	T76P-4020-A11	X	X	X	T88T-4020-B
Screw	T80T-4020-F43	X	X	X	X
Gauge Block	T80T-4020-F42	X	X	X	X
Aligning Adapter	T76P-4020-A3	X			D80T-4020-R60
	T80T-4020-F48		X	X	
Gauge Disc	T78P-4020-A15	X			T88T-4020-A
	D80T-4020-F45		X	X	
Gauge Tube	D80T-4020-F48	X	X	X	D81T-4020-F51
Final Check Gauge Block	D81T-4020-F54	X			D81T-4020-F56
	D81T-4020-F55		X	X	

CE4093-2F

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ASSEMBLY (Continued)

2. Place a new inner pinion bearing cone over the proper aligning adapter and insert into the axle carrier bore. Place the outer pinion bearing cone (new or used if in good condition) into the bearing cup and assemble the handle onto the screw and hand tighten. Note the 3/8 inch square drive in the handle to be used for obtaining the proper pinion bearing preload and tighten to preload of 2.26-4.53 N·m (20-40 in-lbs).



3. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten to 109-147 N·m (80-90 ft-lbs).
4. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge directly along the gauge block to insure a correct reading. The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling. Make sure the shims or feeler gauges are free of dirt to prevent an incorrect reading.
5. After the correct feeler gauge feel is obtained, check the reading and this is the thickness of shim(s) required providing that upon inspection of the service pinion gear, there are no markings.

NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in Step 4.

If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in Step 4.

In addition you must use the exact same new inner pinion bearing that was used in the previous steps.

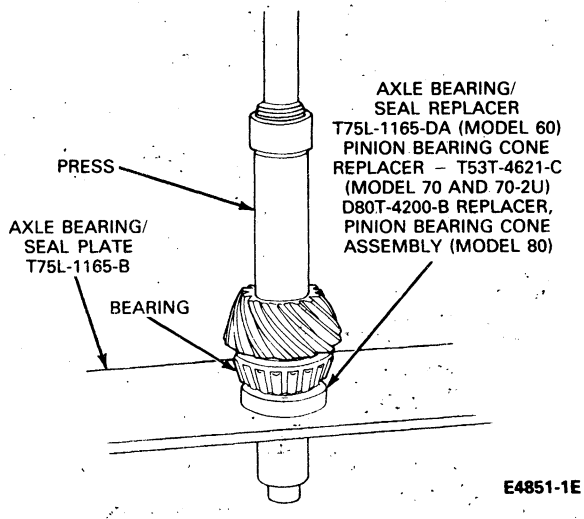
6. Remove the inner pinion bearing cup and install the correct thickness of shims in the carrier bore. Re-install the bearing cup and oil slinger (if used) on the pinion and press on the bearing with T53T-4621-C, for Model 70, T75L-1165-DA for Model 60, or D80T-4200-B for Model 80.

NOTE: If a baffle or slinger is used, replace with a new one upon assembly and measure as part of the shim stack.

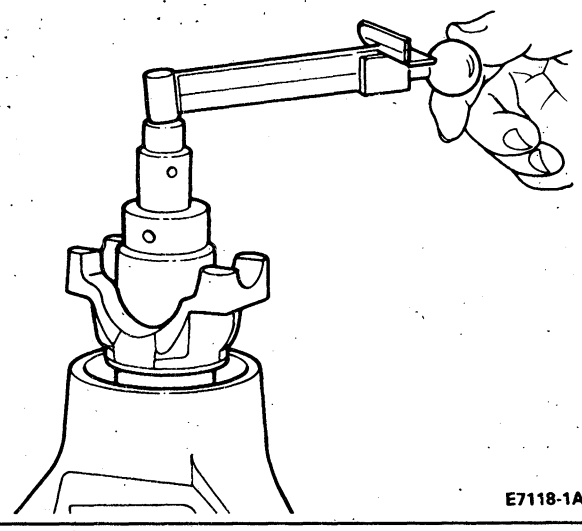
7. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

Pinion Bearing Preload and Final Depth Check

1. Assemble preload shims and spacer or slinger (if used) onto pinion. Assemble bearing cone and roller assembly, using T75L-1165-B, Axle Bearing/Seal Plate and T75L-1165-DA, Axle Bearing/Seal Replacer for Model 60 axles or T53T-4621-C, Pinion Bearing Cone Replacer for Model 70 axles. For Model 80 axle use D80T-4200-B, Pinion Bearing Cone Replacer.



2. Assemble end yoke, washer and new pinion nut on the pinion shaft. Tighten nut to 325-406 N·m (240-300 ft-lbs) for Model 60 and 70 Axles. For Model 80 axles tighten nut to 596-677 N·m (440-500 ft-lbs).

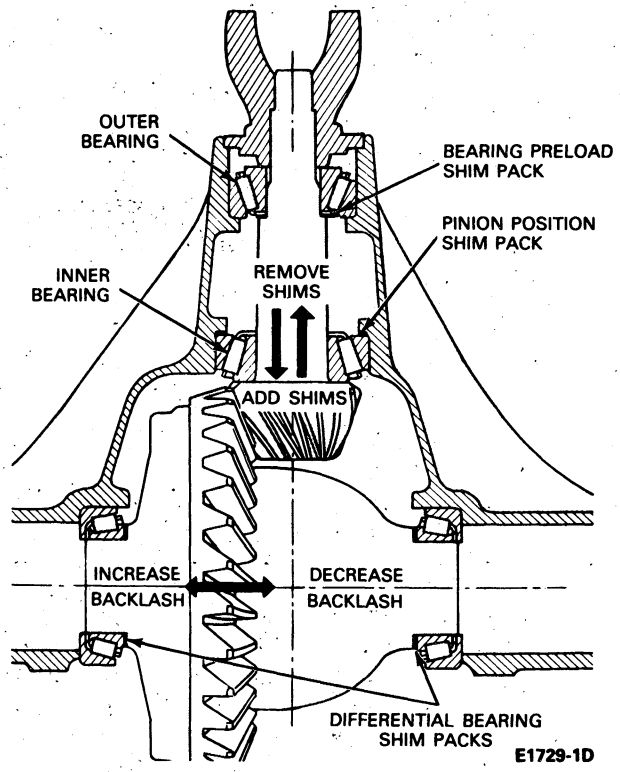


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ASSEMBLY (Continued)

3. Using an inch-pound torque wrench, rotate pinion. Torque to rotate pinion should read between 2.26-4.53 N·m (20-40 in-lbs). To increase preload, remove shims from the outer pinion bearing preload shim pack. To decrease preload, add shims.

The following illustration shows the arrow in the pinion pointing in two directions. The direction pointing towards the end yoke indicates that by removing pinion position shims, the distance from the centerline of the axle to pinion button is increased giving a plus reading. The pinion bearing preload shim pack does not affect the pinion depth setting. Arrows on the ring gear illustrate the method to increase or decrease backlash and differential bearing preload.



The following final depth check may only be performed if the button end of the pinion is a finish ground surface as defined earlier in step 11 of the differential assembly sequence. If the button is not finish ground, the proper pinion position can be verified by the gear contact pattern method outlined at final assembly instructions just before installing the cover.

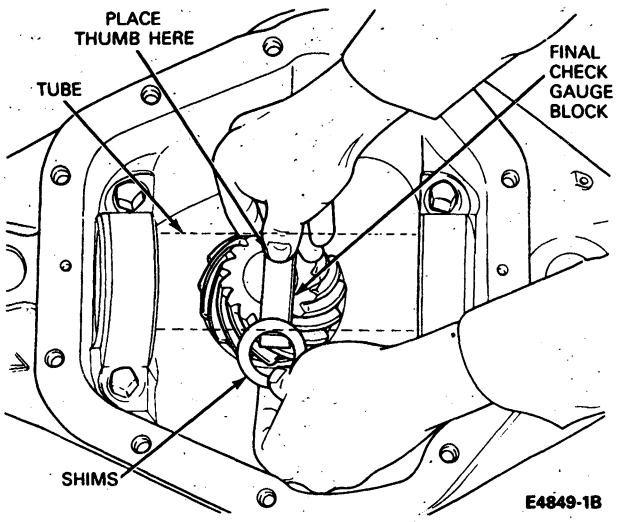
4. Install the Gauge Tube D80T-4020-F48 for Model 60 and Model 70 axles. Use D81T-4020-F51 for Model 80 axle. Install bearing caps and bolts and tighten to 109-147 N·m (80-90 ft-lbs).
5. Insert the Final Check Gauge Block, D81T-40-20-F54 for Model 60 axles or D81T-4020-F55 for Model 70 or D81T-4020-F56 for Model 80 axle on top of the pinion button under the Gauge Tube. Place thumb on the Gauge Block to make sure that the block is level.

Insert feeler gauges or shims between the gauge tube and the Final Check Gauge Block until a slight drag is felt.

The reading should be 0.5mm (0.020 inch) added to the drive pinion etching, which could be 'plus' (+) or 'minus' (-) with a tolerance (±) of 0.050mm (0.002 inch).

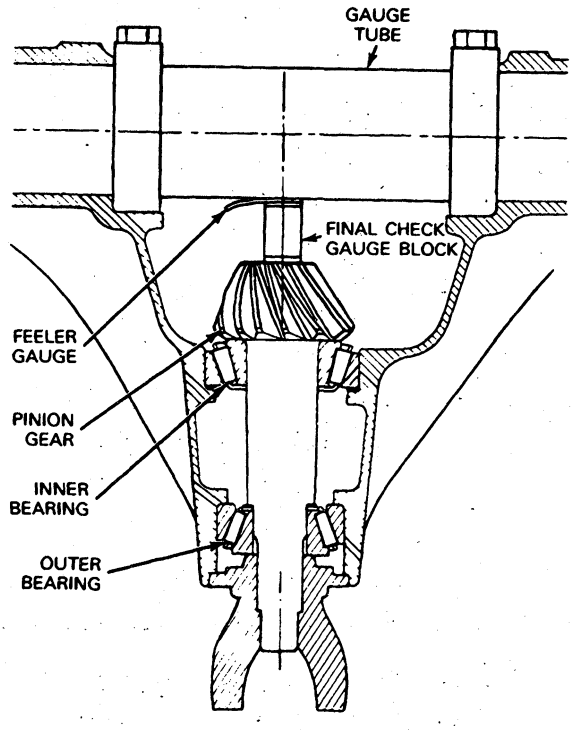
For example: a drive pinion with a '-2' etching would have a 0.45mm (0.018 inch) distance and a tolerance of 0.050mm (0.002 inch), would require 0.40-0.50mm (0.016-0.020 inch) amount of shims.

If the distance must be increased, remove shims from beneath the inner pinion bearing cup. If the distance must be decreased, add shims beneath the inner pinion bearing cup.

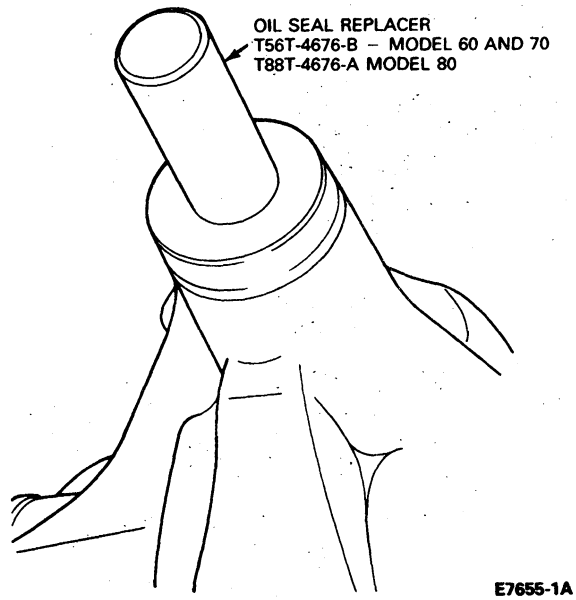


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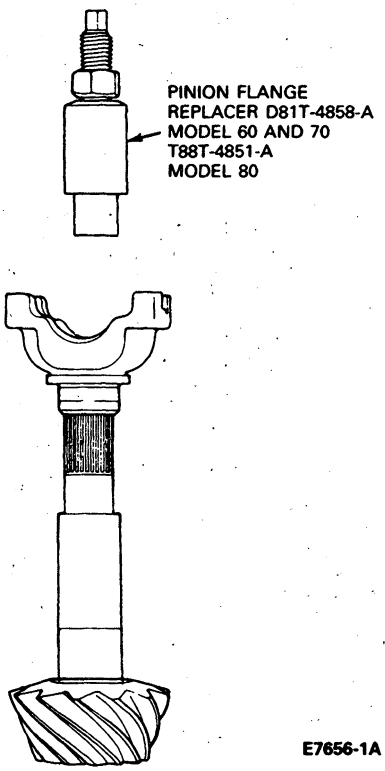
ASSEMBLY (Continued)



6. With the drive pinion at the correct depth, remove the yoke with Holding Tool, T57T-4851-B and Yoke Remover, T65L-4851-B for Model 60, 70 and 80 axles. Remove the yoke, nut and washer.
7. Coat the oil seal with grease. Install the drive pinion oil seal with Oil Seal Replacer, T56T-4676-B (Model 60 and 70). For Model 80 axle use Pinion Seal Replacer T88T-4676-A. After installation, make sure the garter spring did not pop out. If the garter spring pops out, remove and replace seal.



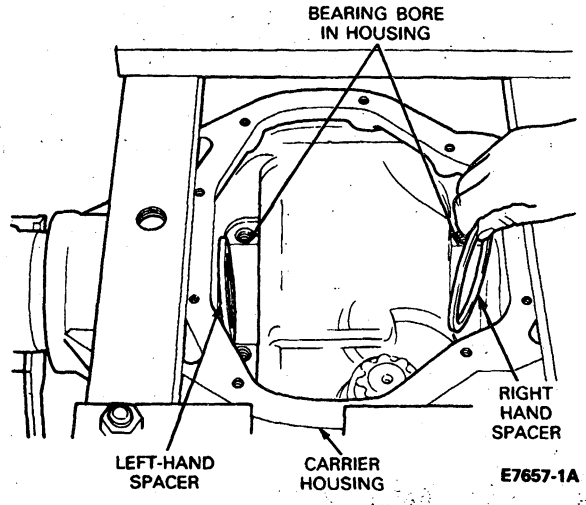
8. Install the yoke with Pinion Flange Replacer, D81T-4858-A for Model 60-70 axles to draw the drive pinion up to engage the nut. Install the washer and nut and tighten nut to 339-366 N·m (250-270 ft-lbs). For Model 80 axles, tighten to 440-500 ft-lbs (596-677 N·m). Use pinion flange replacing tool T88T-4851-A.



Assembly of Differential Into Housing

Ring Gear and Pinion Backlash

1. Place differential assembly into housing. Differential master bearings should still be assembled to case. Install outboard spacers.

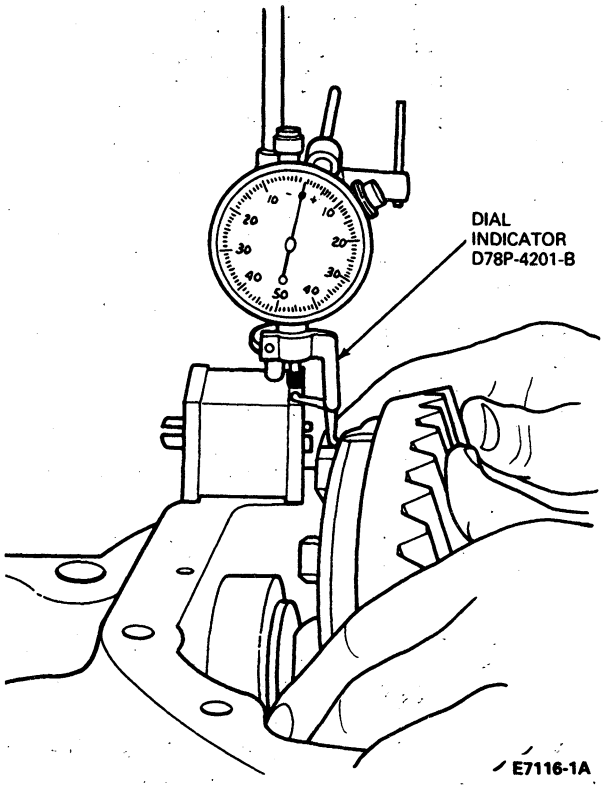


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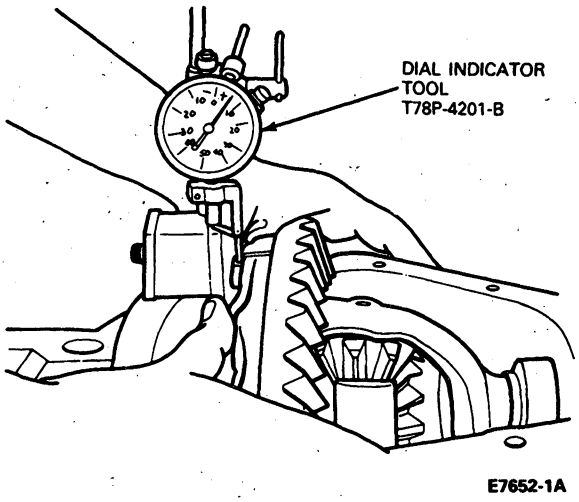
ASSEMBLY (Continued)

2. Set up dial indicator as shown. Be sure to locate dial indicator on a flat surface of one of the ring gear screws.

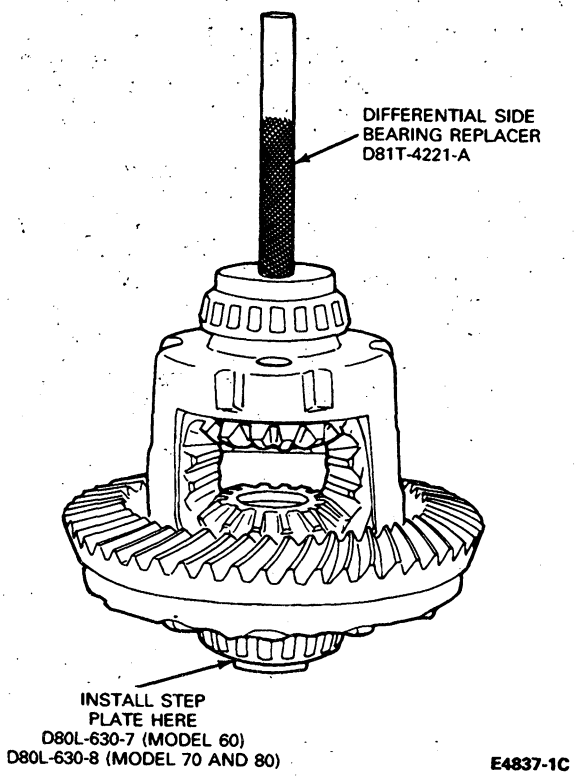
Force the differential case assembly (ring gear) away from the pinion gear. With force still applied to the differential case, set indicator at zero "0".



3. Force the differential case assembly (ring gear) into mesh with the pinion gear to obtain an indicator reading. Repeat until the same reading is obtained each time. This reading will be the necessary amount of shims required between the differential case and differential bearings on the ring gear side. Remove indicator and differential case from the carrier. Remove master bearings from differential case.
4. As determined in Step 3 place the required amount of shims on the ring gear hub of the differential case. For example: if the reading in Step 3 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.



5. Install the bearing cone on the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer, D81T-4221-A.



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ASSEMBLY (Continued)

6. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in Step 3 from the Total Differential Case Endplay. Total Case Endplay was determined under Steps 9 and 10 of Differential Case-Assembly. When this amount is determined, add 0.36mm (0.015 inch) to the amount for a Model 60, or 0.25mm (0.010 in) for Models 70-80. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

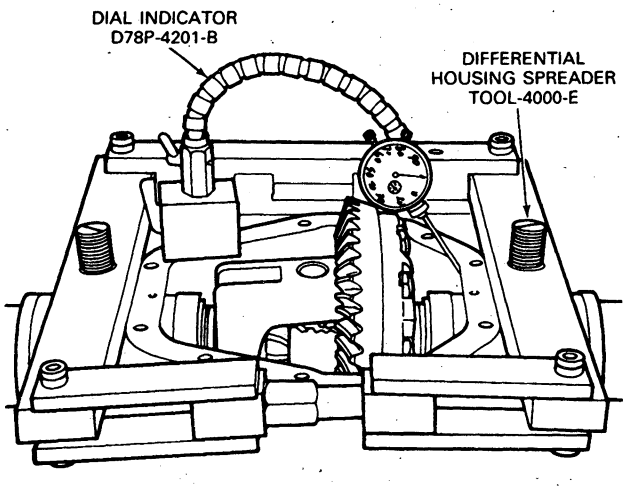
   For example: Total Differential Case Endplay on a Model 60 was 2.30mm (0.091 inch). The reading in Step 3 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch). 0.36mm (0.015 inch) is added to give 1.52mm (0.061 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.

7. Place the required amount of shims on the hub of the drive pinion side of the differential case.

8. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate D80L-630-7 for Model 60 axles and D80L-630-8 on Model 70 and 80 axles on the ring gear side bearing to protect the bearing during installation of the drive pinion side bearing. Place the bearing on the drive pinion side hub and drive it on using Differential Side Bearing Replacer, D81T-4221-A.

9. Install spreader Tool-4000-E and indicator D78P-4201-B to carrier. Do not spread carrier over 0.38mm (0.015 inch). Remove indicator.

CAUTION: Do not spread carrier over 0.38mm (0.015 inch).

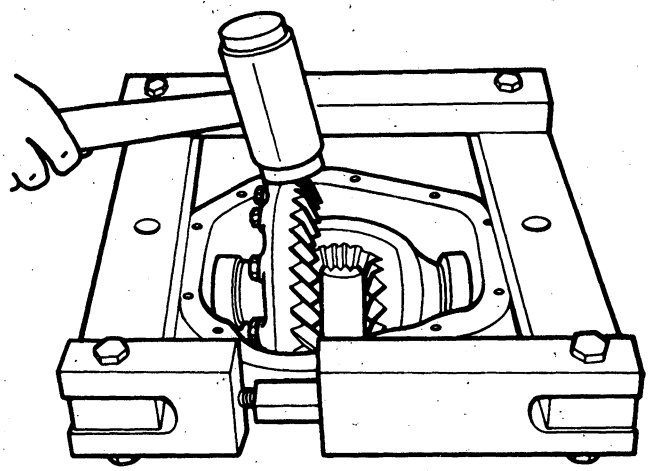


E4833-1B

Final Assembly—Differential into Housing

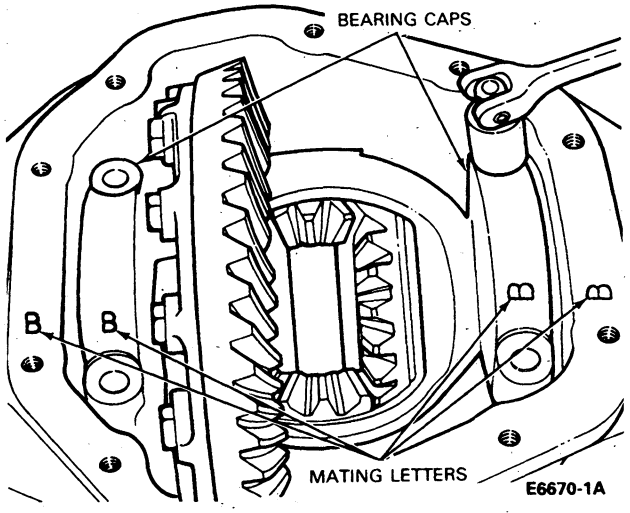
1. Assemble differential bearing cups to differential bearing cones. Install differential assembly into carrier.

   Use a rawhide hammer to seat differential assembly into crossbore of carrier. Care should be taken to avoid nicking the teeth of the ring gear and pinion during assembly. Remove the spreader from the carrier.



E6409-1A

2. Install bearing caps. Make sure the letters stamped on the caps correspond with those on the carriers. Tighten bearing cap screws to 108-122 N·m (80-90 ft-lbs).



E6670-1A

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ASSEMBLY (Continued)

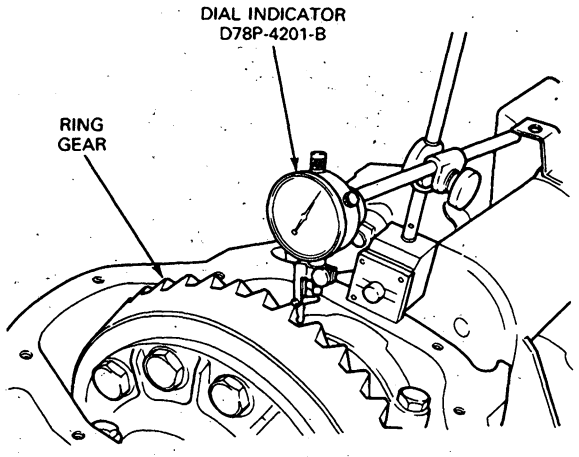
3. Check ring gear and pinion backlash in three equally spaced points with dial indicator.

Backlash tolerance is 0.13-0.203mm (0.005-0.008 inch) and cannot vary more than 0.05mm (0.002 inch) between points checked.

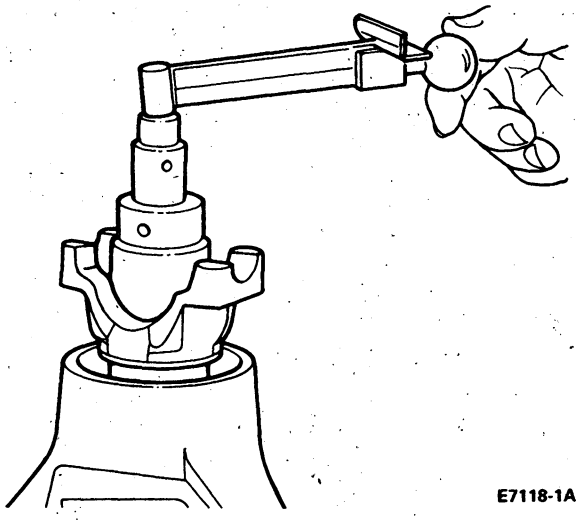
High backlash is corrected by moving the ring gear closer to the pinion.

Low backlash is corrected by moving ring gear away from the pinion.

These corrections are made by switching shims from one side of the differential case to the other.



E7500-1A



E7118-1A

4. To confirm total preload, recheck torque to rotate with an inch-pound wrench as shown. The reading should be higher than the initial reading (taken without the differential case installed) by the following amount if new bearings have been installed as recommended:

   3.54 & 3.73 ratios = 7-9 in-lbs.

   4.10 & 4.56 ratios = 6-8 in-lbs.

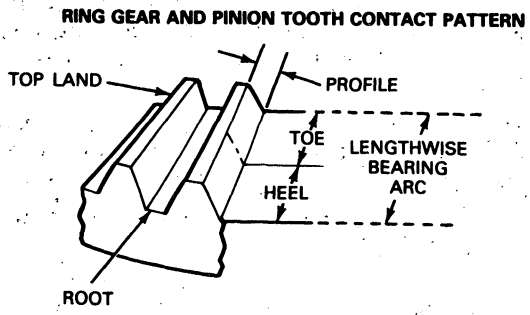
   4.63 & 5.13 ratios = 6-8 in-lbs.

   If total preload is too high, remove an equal amount of shims from each differential case hub.

   If total preload is too low, add an equal amount of shims to each differential case hub.

Ring Gear & Pinion Tooth Pattern Interpretation

5. The final pinion position will be verified by using the GEAR CONTACT PATTERN METHOD, described below as follows:



E8231-1A

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ASSEMBLY (Continued)

6. The TOE of the gear tooth is the portion of the tooth surface at the end towards the center. The HEEL of the gear tooth is the portion of the tooth surface at the outer end. The TOP LAND of the gear tooth is the surface of the top of the tooth. Every gear has a characteristic pattern. The illustrations show typical patterns only, and explains how patterns shift as gear location is changed. When making pinion position changes, shims should be changed in the range of .05mm (.002 inch) to .10mm (.004 inch) until correct pattern has been obtained.

When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .10mm (.004 inch), the shim pack should be changed by .15mm (.006 inch) as a starting point. The actual amount of backlash change obtained will vary depending upon the ratio and gear size.

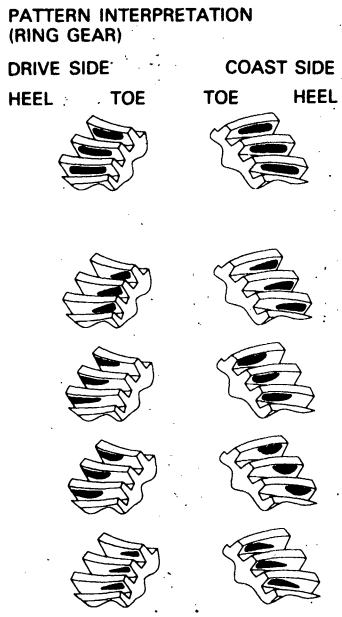
High backlash is corrected by moving the ring gear closer to the pinion. Low backlash is corrected by moving the ring gear away from the pinion. These corrections are made by switching shims from one side of the differential case to the other.

NOTE: When making changes, note that two variables are involved. Example: If you have the backlash set correctly to specifications and you change the pinion position shim, you may have to readjust the backlash to the correct specification before checking the pattern. Refer to pattern interpretation.

WARNING: GEAR TEETH MAY HAVE SHARP EDGES. WHEN HANDLING GEARS, USE CARE TO AVOID PERSONAL INJURY.

a. Paint ring gear teeth with a marking compound to both the drive and coast side.

b. Rotate ring gear one complete revolution in both directions while load is being applied with a large screwdriver or similar tool between the carrier casting and differential case flange.



NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

BACKLASH CORRECT. THINNER PINION POSITION SHIM REQUIRED.

BACKLASH CORRECT. THICKER PINION POSITION SHIM REQUIRED.

PINION POSITION SHIM CORRECT. DECREASE BACKLASH.

PINION POSITION SHIM CORRECT. INCREASE BACKLASH.

E8232-2A

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ASSEMBLY (Continued)

Pattern Movements Summarized

a. Decreasing backlash moves the ring gear closer to the pinion.

Drive pattern (convex side of gear) moves slightly lower and toward the toe.

Coast pattern (concave side of gear) moves lower and toward the toe.

b. Increasing backlash moves the ring gear away from the pinion.

Drive pattern moves slightly higher and toward the heel.

Coast pattern moves higher and towards the heel.

c. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

Drive pattern moves deeper on the tooth (flank contact) and slightly toward the toe.

Coast pattern moves deeper on the tooth and toward the heel.

d. Thinner pinion position shim with the backlash constant moves the pinion further from the ring gear.

Drive pattern moves toward the top of the tooth (face contact) and toward the heel.

Coast pattern moves toward the top of the tooth and slightly toward the toe.

7. Install new cover gasket and install cover plate. Tighten screws to 41-54 N·m (30-40 ft-lbs.).

Figure shows the flat mounting surface cover plate on Dana design axles. This cover plate requires the use of a silicone rubber sealer material, Silicone Rubber E7TZ-19562-A (ESL-M4G273-A), or equivalent rather than a gasket.

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

CAUTION: Clean both flat surfaces with a suitable solvent to remove all traces of oil film.

Sealant material must meet specifications of ESL-M4G273-A, ASTM1, GE503, Z1, Z2 and Z3 sealant or equivalent.

8. Apply Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

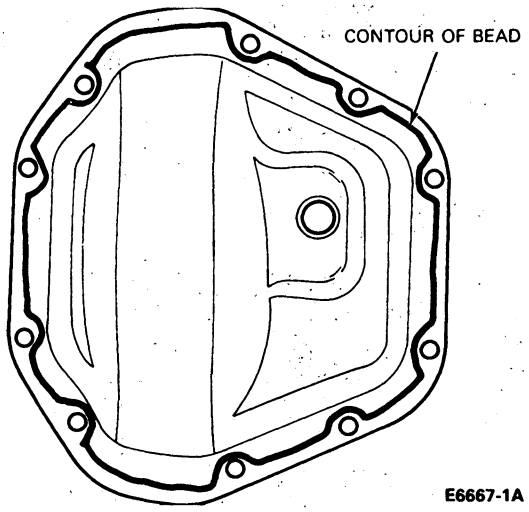
The bead is to be 3.18-6.35mm (1/8 inch to 1/4 inch) wide.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.

Assemble two cover screws into cover at 8 o'clock and 2 o'clock position. Use these two holes to guide cover plate into position on the carrier.

Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lbs.).

ALLOW ONE HOUR CURE TIME BEFORE FILLING CARRIER WITH THE PROPER AMOUNT OF SPECIFIED LUBRICANT. Refer to the Specifications portion of this Section.



9. Install axle shafts as outlined under axle shaft removal in Section 11-14.

10. Fill axle housing with specified amount of Rear Axle Lubricant, C6AZ-19580-E (ESW-M2C105-A) rear axle lubricant.

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SPECIFICATIONS

Axle Model	Ford Specification	Approx. Capacities		
		U.S. Pts.	Imp. Pts.	Liters
60-1U	ESW-M2C105-A (C6AZ-19580-E)	6.3	5.2	3.0
70-2u	ESW-M2C105A (C6AZ-19580-E)	6.6	5.5	3.1
80	ESW-M2C105-A (C6AZ-19580-E)	8.5	6.8	4.0

NOTE: Additive friction modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent for complete refill of Dana limited-slip axles. Add 0.2 liter (8 oz.) for E250—E-350 complete refill.

CE4098-2K

DANA AXLE ADJUSTMENTS

Description	Specification	Description	Specification
Backlash Between Ring Gear and Pinion	0.13-0.20 mm (0.005-0.008 inch)	Pinion Bearing Preload (with new bearings)	2.26-4.53 N•m (20-40 in-lbs)
Backlash Maximum Variation Between Teeth	0.05 mm (0.002 inch)	Total (pinion plus differential) Preload with new bearings	Add 6-9 in-lbs, depending on ratio, to pinion preload.

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SPECIFICATIONS (Continued)

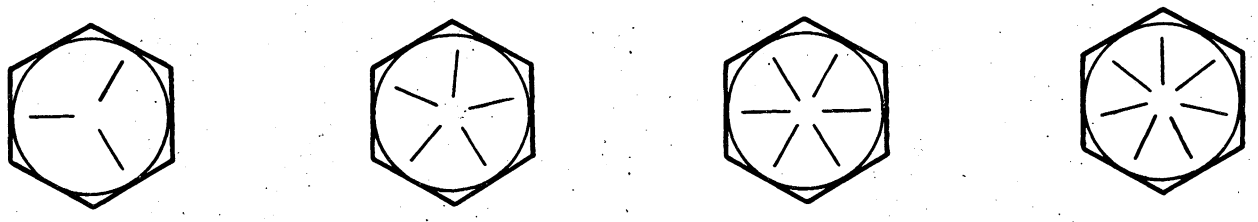
DANA AXLE TORQUE LIMITS

Description	Axle Model					
	60, 61		70		80	
	Ft-Lbs	N-m	Ft-Lbs	N-m	Ft-Lbs	N-m
Pinion Shaft Nut	250-270	339-366	250-270	339-366	440-500	596-677
Differential Bearing Cap Bolts	80-90	109-147	80-90	109-147	80-90	109-147
Ring Gear Attaching Bolts*	100-120 *	136-163 *	100-120	136-163	200-240	272-330
Oil Filler Plug — 1/4 Inch Recess Drive	15-25	20-33	15-25	20-33	15-25	20-33
U-Joint Bolts	15-20	21-27	15-20	21-27	—	—
Cover to Housing Bolts	30-40	41-54	30-40	41-54	30-40	41-54

*If special high strength screws are used, torque is 125-135 ft-lbs. (169-183 N-m). High strength screws can be identified by 7 radial lines on screw head. Grade 8 screws will have 6 radial lines on screw heads.

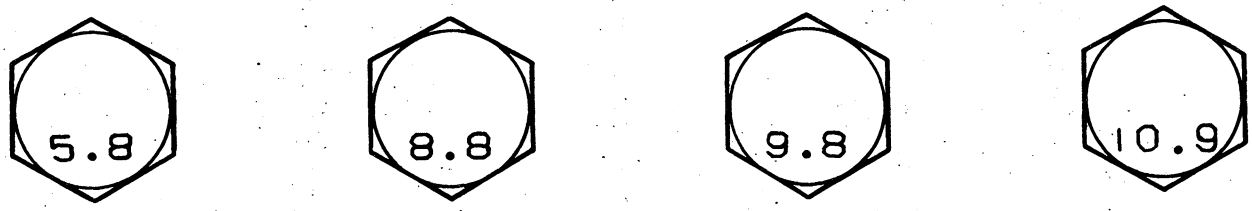
WARNING

IF FASTENERS OF A LOWER GRADE OR CLASS ARE TORQUED TO THE REQUIREMENTS OF A HIGHER GRADE OR CLASS FASTENER, IT MAY RESULT IN COMPONENT FAILURE. (E.G. GRADE 5 FASTENER TORQUED TO THE REQUIREMENTS OF A GRADE 8 FASTENER.)



GRADE 5 GRADE 7 GRADE 8 SPECIAL GRADE (High Strength Applications)

Customary (Inch) Bolts-identification marks correspond to bolt strength-increasing numbers represent increasing strength.



Metric Bolts-identification class numbers correspond to bolt strength-increasing numbers represent increasing strength.

Inch grade fasteners can be identified by the radial lines embossed upon the head of the fastener and will correspond to the fastener strength by two-lines less than actual grade (i.e., grade 8 fastener will display 6 radial lines on the head).

Metric fastener strength can be identified with the class identification embossed on the head of each fastener. Increasing numbers represent increasing strength.

CE7751-2B

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SPECIFICATIONS (Continued)

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Oil Seal Removal
D80L-630-1	Step Plate	Wheel Bearing Installation
D80L-630-7	Step Plate	Differential Side Bearing Installation — Model 60
D80L-630-8	Step Plate	Differential Side Bearing Installation — Model 70-80
T77F-1102-A	Bearing Cup Puller	Oil Seal Removal
D81T-1104-A	Adapter — Fine Thread	Wheel Bearing Removal
T81P-1104-B	Adapter — Coarse Thread	Wheel Bearing Removal
T81P-1104-C	Push Puller	Wheel Bearing Removal
T75L-1165-B	Axle Bearing/Seal Plate	Drive Pinion Bearing Installation
T75L-1165-DA	Axle Bearing/Seal Replacer	Drive Pinion Bearing Installation — Model 60
T75T-1176-A	Threaded Drawbar	Bearing Cup Installation
T81T-1225-A	Rear Wheel Bearing Remover	Wheel Bearing Removal
Tool-4000-E	Housing Spreader	Differential Case Removal and Installation
D81L-4000-A	Drive Handle	Bearing Cup Removal
T80T-4000-W	Driver Handle	Bearing Cup Removal and Installation
T80T-4000-X	Rear Axle Seal Wheel Bearing Replacer	Wheel Bearing Installation
T80T-4000-Y	Rear Oil Seal Replacer	Oil Seal Installation
T80T-4020-A	Pinion Depth Gauge	Axle Adjustments — Model 60 and 70
D80T-4020-F48	Aligning Adapter	Axle Adjustments — Model 60-70
D78P-4201-B	Dial Indicator, Magnetic Base	Axle Adjustments
D81L-4220-A	Universal Bearing Puller	Bearing Removal
D81T-4221-A	Differential Bearing Cone Replacer	Differential Side Bearing Installation — Model 60-70
D81T-4222-D	Master Bearings	Axle Adjustments — Model 60 and 70-2u
D81T-4616-A	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 70-80
T56T-4616-B1	Bearing Cup Replacer	Outer Bearing Cup Installation — Model 60-70
T56T-4616-B2	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 60 Outer Bearing Cup Installation — Model 70
T53T-4621-C	Pinion Bearing Cone Replacer	Drive Pinion Bearing Replacer — Model 70
D81T-4628-A	Bearing Cup Remover	Inner Bearing Cup Removal — Model 60-70
D81T-4628-B	Bearing Cup Remover	Inner Bearing Cup Removal — Model 70
D81T-4628-D	Bearing Cup Remover	Outer Bearing Cup Removal
D81T-4628-X	Pinion Bearing Cup Remover Set	Model 60 and 70 — Model 60-70
T56T-4676-B	Oil Seal Replacer	Oil Seal Installation
T57T-4851-B	Companion Flange Holding Tool	Yoke Removal and Installation
T65L-4851-B	Companion Flange Remover	Yoke Removal — Model 60-70-80
D81T-4858-A	Companion Flange Replacer	Yoke Installation — Model 60-70

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SPECIFICATIONS (Continued)

Number	Description	Application
TOOL-1175-AC	Oil Seal Remover	Pinion Oil Seal
D80L-1002-L	2-Jaw Puller	Pinion Flange Removal
D80T-4020-R60	Aligning Adapter	Axle Adjustment
D81T-4020-F51	Gauge Tube	Axle Adjustment Model 80
D81T-4020-F54	Gauge Block	Axle Adjustment Model 60
D81T-4020-F55	Gauge Block	Axle Adjustment Model 70
D81T-4020-F56	Gauge Block	Axle Adjustment Model 80
D80T-4200-B	Bearing Cone Replacer	Pinion Bearing Model 80
D81T-4222-E	Master Bearing-Diff. Case	Axle Adjustment Model 80
T67P-4616-A	Bearing Cup Replacer	Outer Pinion Bearing Cup Model 80
T88T-4628-A	Bearing Cup Remover	Inner Pinion Bearing Model 80
T88T-4676-A	Oil Seal Replacer	Pinion Oil Seal Model 80
T83T-4676-A	Oil Seal Replacer	Pinion Oil Seal Model 60-70
T88T-4851-A	Pinion Flange Replacer	Model 80
T85T-4851-AH	Pinion Flange Replacer	Model 60-70

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Notes

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Notes

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SECTION 15-08 Integral Carrier Axle—8.8 Inch Ring Gear

SUBJECT	PAGE
CLEANING AND INSPECTION	
Inspection After Disassembly	15-08-4
Bearing Cups	15-08-5
Carrier Housing	15-08-5
Companion Flange	15-08-5
Cone and Roller Assemblies	15-08-5
Differential Case	15-08-5
Gears	15-08-5
Inspection Before Disassembly	15-08-4
DESCRIPTION AND OPERATION	
Description	15-08-1
Operation	15-08-2
Rear Antilock Brakes	15-08-2
DISASSEMBLY AND ASSEMBLY	
Axle—Assembly	15-08-14
Companion Flange Installation	15-08-16
Differential Case	15-08-18
Drive Pinion Shim Selection	15-08-14

SUBJECT	PAGE
DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Axle—Assembly (Cont'd.)	
Pinion Bearing Cup	15-08-14
Wheel Bearing and Oil Seal Installation	15-08-17
Axle—Disassembly	15-08-5
Pinion Oil Seal	15-08-5
Axle Shaft	15-08-7
Axle Housing	15-08-12
Differential Case	15-08-8
Differential Runout Check	15-08-11
Drive Pinion	15-08-10
Oil Seal and Wheel Bearing	15-08-8
Pinion Bearing Cup	15-08-11
Ring Gear	15-08-9
Rear Antilock Brake System Sensor (F-150 and Bronco only)	15-08-25
SPECIFICATIONS	15-08-25
VEHICLE APPLICATION	15-08-1

VEHICLE APPLICATION

E-150, F-150 and Bronco Vehicles.

DESCRIPTION AND OPERATION

Description

The Ford Truck Integral Carrier rear axle assembly is an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of an 8.8 inch diameter ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings. Pinion bearing preload is adjusted by the pinion nut and a collapsible spacer maintains the seating of the inner race.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses a silicone sealant as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion shaft is retained with a threaded bolt assembled to the case. The differential case assembly is mounted in the carrier between two opposed tapered roller bearings. The bearings are retained in the carrier by removable bearing caps.

The axle is available in two models to accommodate tread width differences between the vehicle lines. They are similar except for minor suspension bracket connections and variations in axle shaft and housing tube lengths.

- Differential Bearing Preload and Ring Gear Backlash are adjusted by the use of shims located between the Differential Bearing Cup/Races and the Carrier Housing.
- The use of a Pinion Depth Gauge Tool for drive pinion shim selection in conjunction with a dial indicator for differential case shim selection is required for proper gear set adjustment.
- The Semi-Floating Axle Shafts are held in the Housing by C-washer locks positioned in a slot on the Axle Shaft Splined End. These C-washers also fit into a machined recess in the differential side gears within the differential case.

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DESCRIPTION AND OPERATION (Continued)

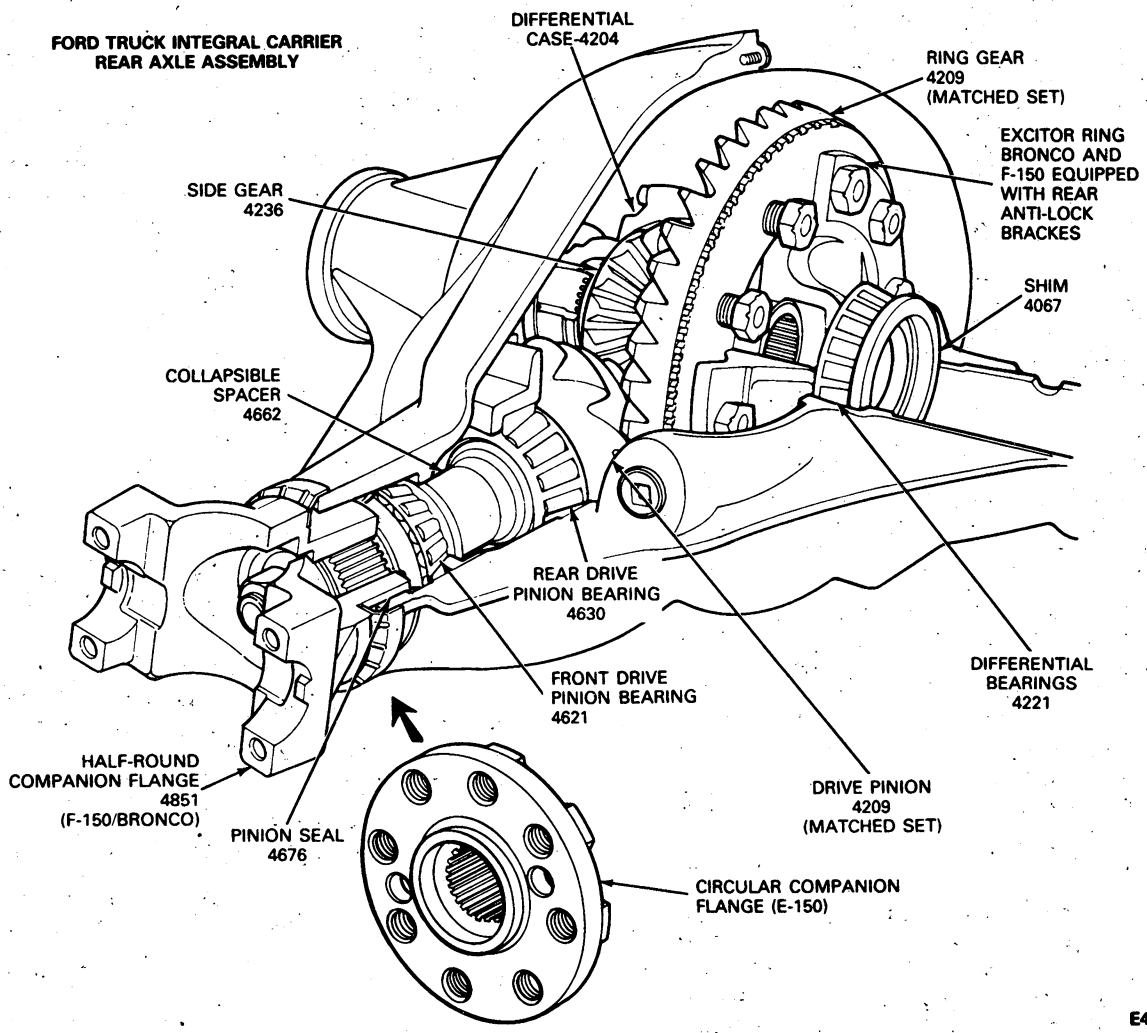
Rear Antilock Brakes

F-150 and Bronco vehicles use the Rear Antilock Brake System (RABS). The system features a multi-tooth excitor ring that is pressed on the differential case behind the ring gear. If the excitor ring is removed, it must be discarded and replaced with a new one. The excitor ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space provided between the ring gear and excitor ring for measuring the ring gear backface runout.

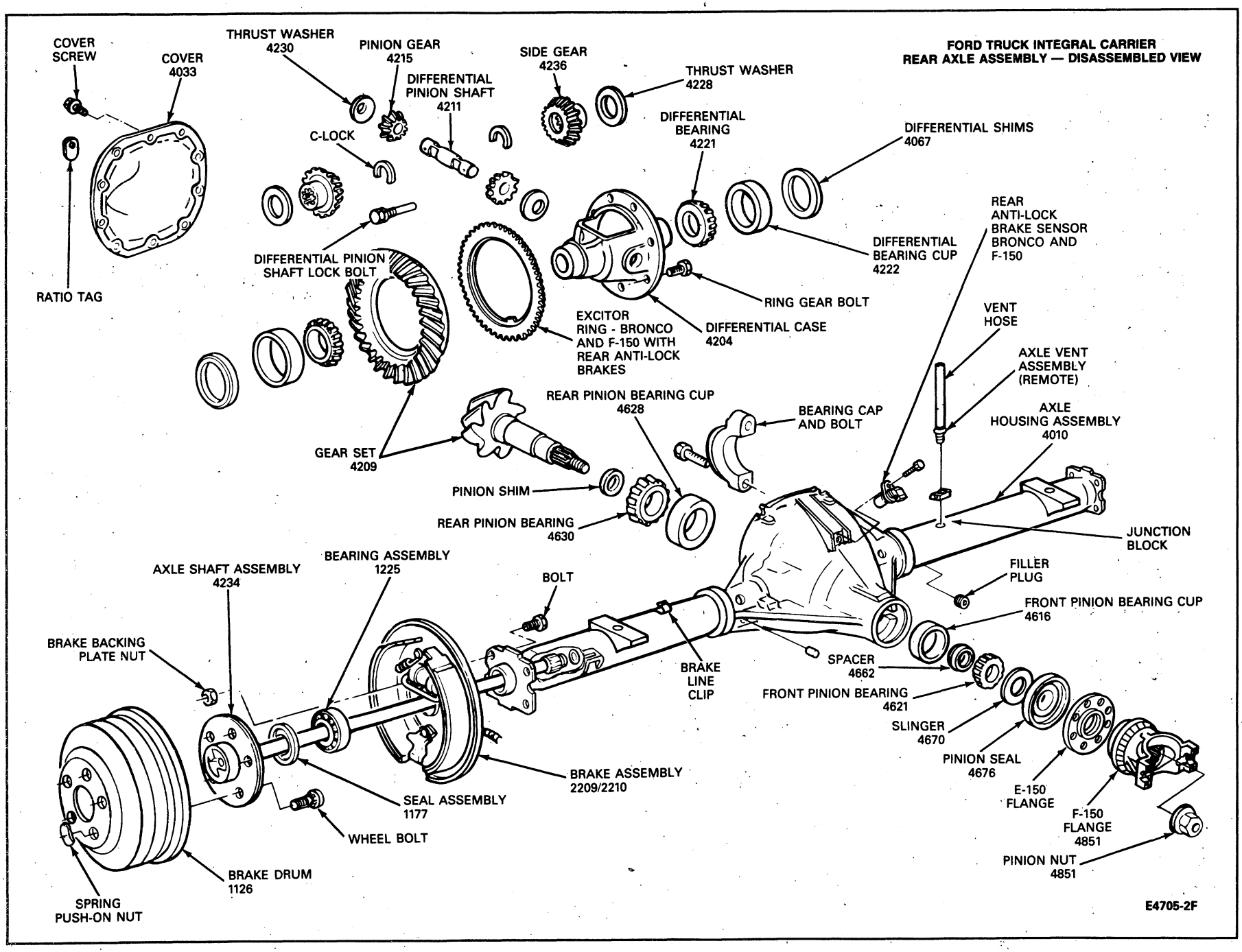
Operation

The rear axle drive pinion receives its power from the engine through the transmission and driveshaft. The pinion gear rotates the differential case through engagement with the ring gear, which is bolted to the case outer flange.

Inside the case, two differential pinion gears are mounted on the differential pinion shaft which is pinned (with lock bolt) to the case. These pinion gears are engaged with the side gears, to which the axle shafts are splined. Therefore, as the differential case turns, it rotates the axle shafts and rear wheels. When it is necessary for one wheel and axle shaft to rotate faster than the other, the faster turning side gear causes the pinions to roll on the slower turning side gear to allow differential action between the two axle shafts.



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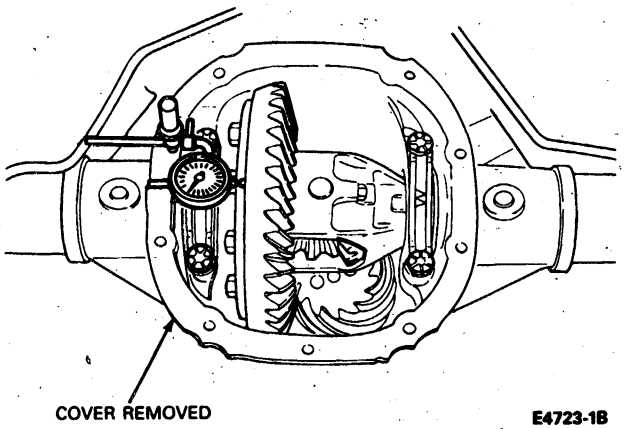
CLEANING AND INSPECTION

Inspection Before Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the carrier. These inspections can find the cause of the concern and determine the resolution.

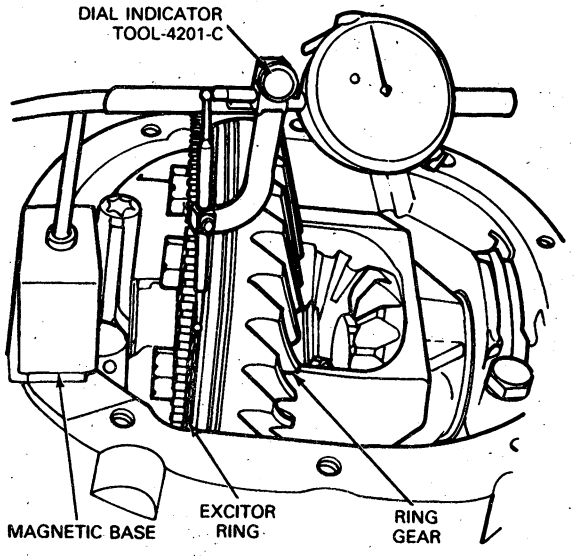
1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.

RING GEAR BACKFACE RUNOUT



E4723-1B

RING GEAR BACKFACE RUNOUT
REAR ANTI-LOCK BRAKE VEHICLES



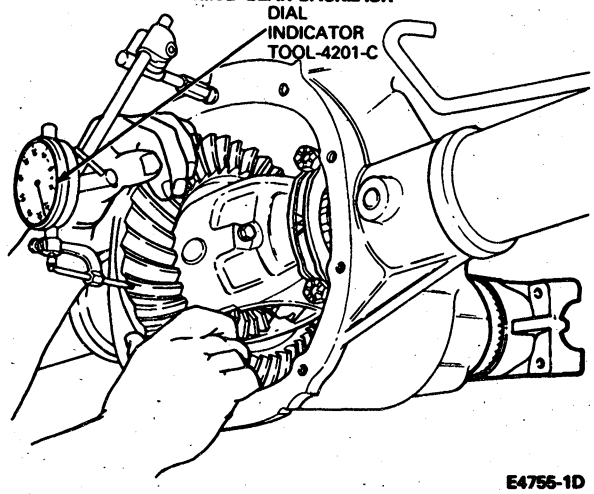
E7162-1B

4. On E-150 vehicles, set up a dial indicator and check ring gear backlash and ring gear backface runout. On Bronco and F-150 vehicles equipped with rear Antilock brakes, mount Dial Indicator, TOOL-4201-C, or equivalent, on the carrier so the tip of the dial indicator contacts the backface of the ring gear.

NOTE: There is a space provided between the excitor ring and the ring gear for measuring ring gear backface runout. Backlash should be 0.008 inch to 0.015 inch (0.012-0.015 inch preferred) and backface runout should be no more than 0.004 inch.

5. A contact pattern is not an acceptable guide to check for noise. Proper gear set assembly must be checked using the pinion depth gauge Tool T79P-4020-A which shows the correct pinion shim required. See Section on Drive Pinion and Gear Set.

RING GEAR BACKLASH



E4755-1D

Inspection After Disassembly

Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air. Oil the bearings immediately to prevent rusting. Inspect the parts for any major damage. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.

Sensor

Inspect the Rear Antilock Brake System (RABS) Sensor pole piece for loose metal particles and clean if required.

Excitor Ring

Examine the Rear Antilock Brake System (RABS) excitor ring to see that it is firmly pressed onto the differential case and check it for dented, chipped or missing teeth that could result in erratic RABS preformance. If damage is found, remove and replace excitor ring.

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CLEANING AND INSPECTION (Continued)

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be reseated.

Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Companion Flange

Be sure that the flange half-rounds and lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

NOTE: Bronco and F-150 vehicles are equipped with half-round companion flanges. E-Series vehicles are equipped with a circular companion flange.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

DISASSEMBLY AND ASSEMBLY

Axle—Disassembly

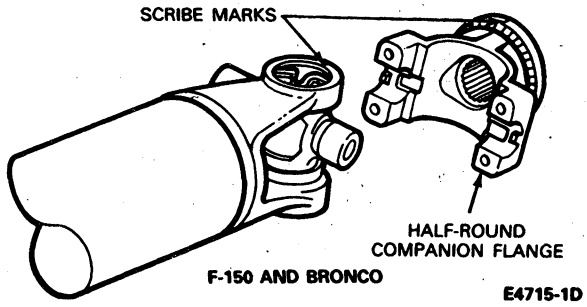
Pinion Oil Seal

Removal

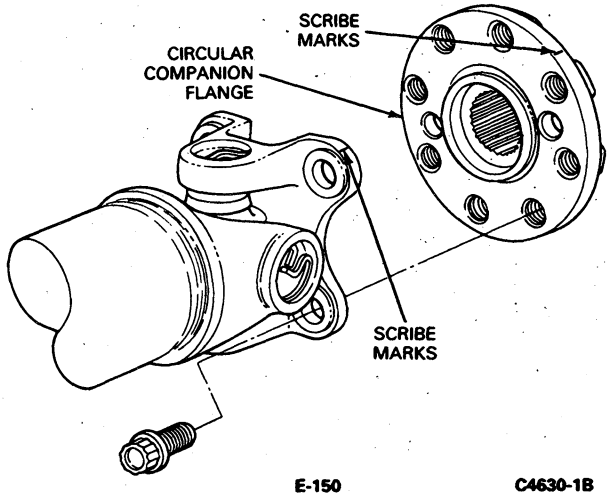
Replacement of the pinion oil seal involves removal and installation of only the drive pinion shaft nut and the companion flange.

CAUTION—This operation disturbs the pinion bearing preload, and this preload must be carefully reset when assembling.

1. Raise the vehicle and install safety stands. Remove the rear wheels and brake drums to prevent brake drag during drive pinion bearing preload adjustment.
2. Mark the driveshaft axle end flange and the axle companion flange to insure proper position of the driveshaft during assembly. Disconnect the driveshaft from the rear axle companion flange. Remove the driveshaft from the transmission extension housing. Install an oil seal replacer tool in the transmission extension housing to prevent oil leakage.



F-150 AND BRONCO E4715-1D

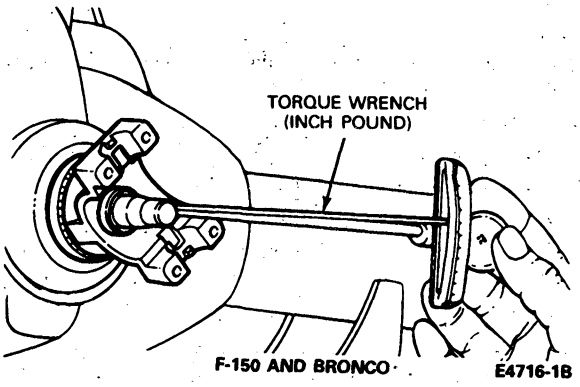


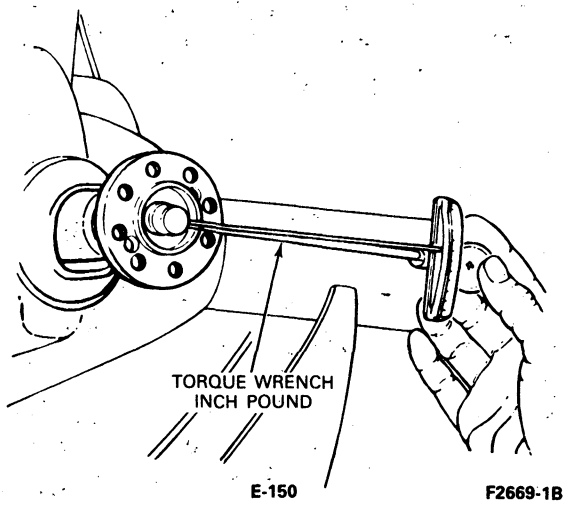
E-150 C4630-1B

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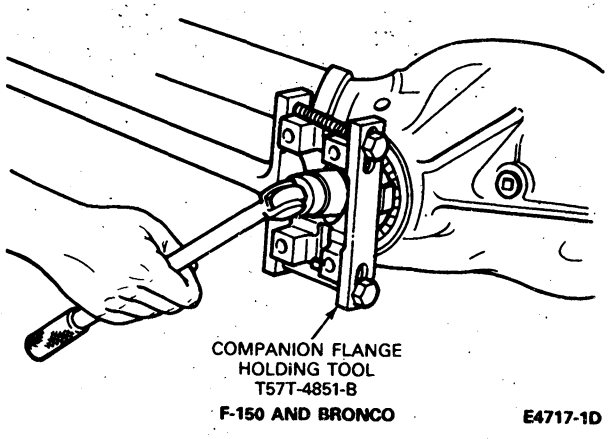
DISASSEMBLY AND ASSEMBLY (Continued)

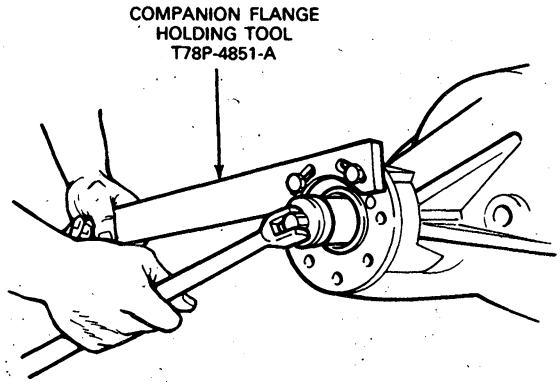
3. Install an inch pound torque wrench on the pinion nut. Record the torque required to maintain rotation of the pinion through several revolutions.





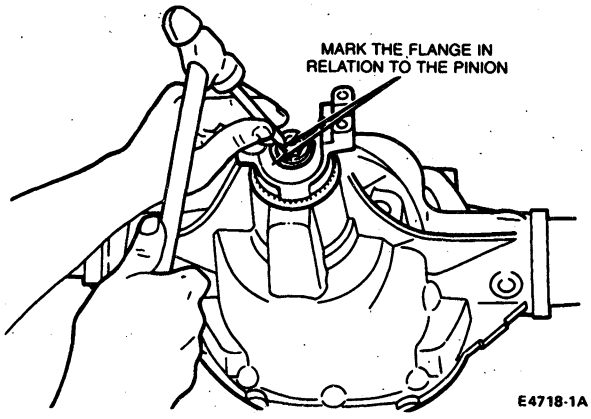
4. While holding the companion flange with Companion Flange Holding Tool, T57T-4851-B or equivalent, remove the pinion nut.





5. Clean the area around the oil seal. Place a drain pan under the seal, or raise the front of the vehicle higher than the rear.

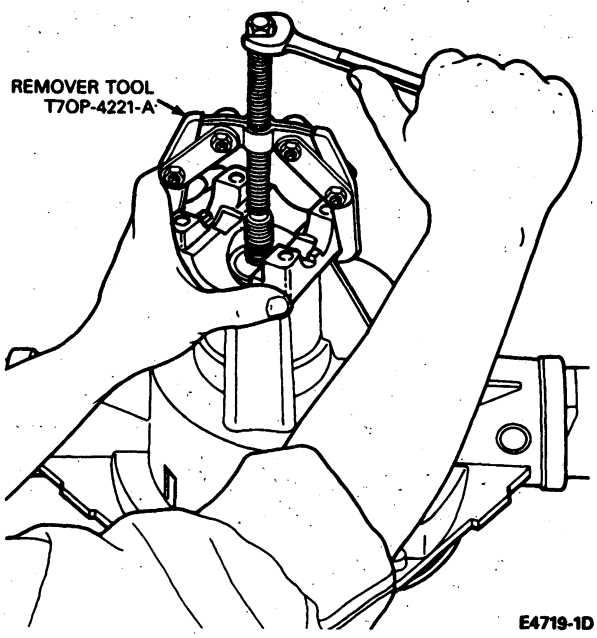
   Mark the companion flange in relation to pinion so flange can be reinstalled in the same position.



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DISASSEMBLY AND ASSEMBLY (Continued)

6. Using Remover Tool, T70P-4221-A or equivalent remove the rear axle companion flange.



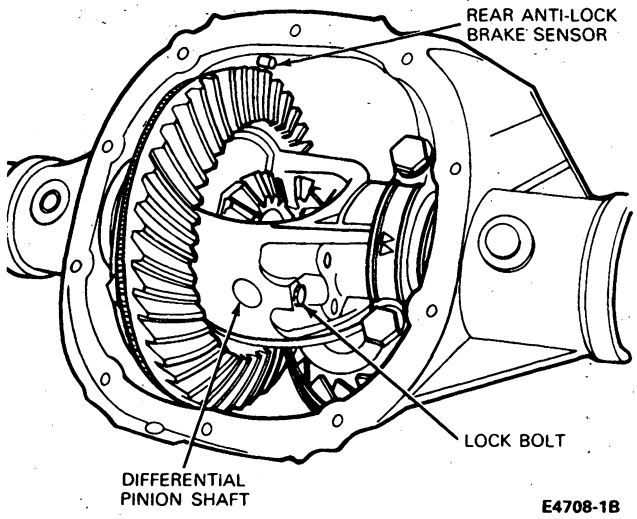
Axle Shaft

Removal

8. Clean all dirt from the area of carrier cover with a wire brush and/or cloth.

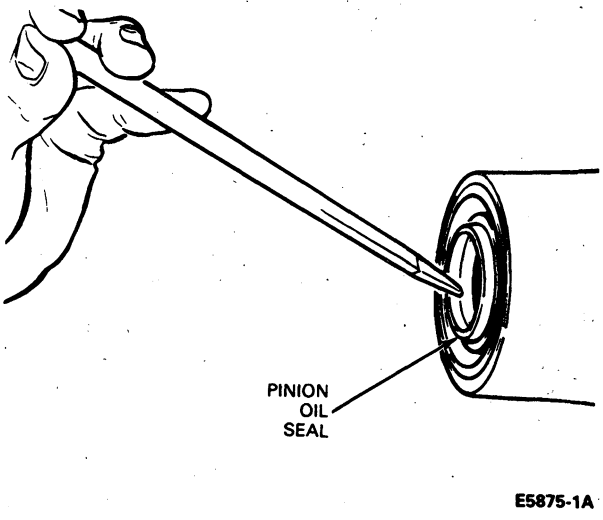
   Drain rear axle lubricant by removing the housing cover.

   Remove differential pinion shaft lock bolt and differential pinion shaft.



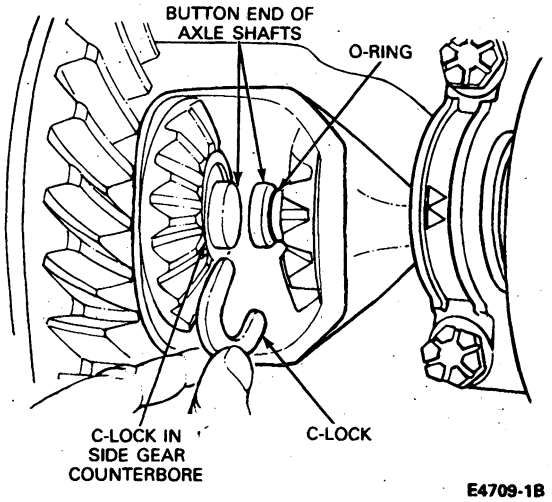
7. Remove the drive pinion oil seal.

CAUTION: Use care not to damage seal bore in housing.



9. Push the flanged end of the axle shafts inboard and remove the C-lock from the button end of each axle shaft.

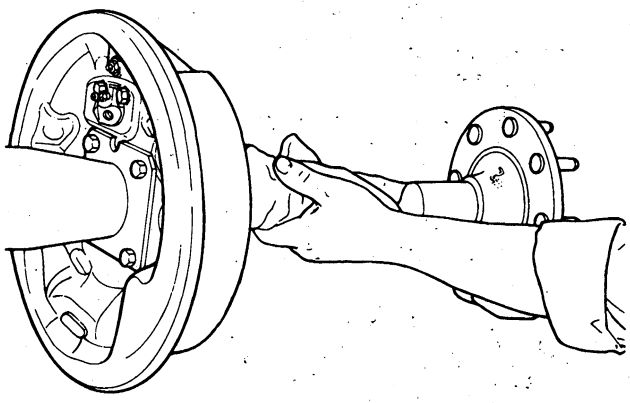
NOTE: Use care not to lose or damage the rubber O-ring which is in the axle shaft groove under the C-lock.



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DISASSEMBLY AND ASSEMBLY (Continued)

10. Remove the axle shaft from the housing, being careful not to damage the oil seal.

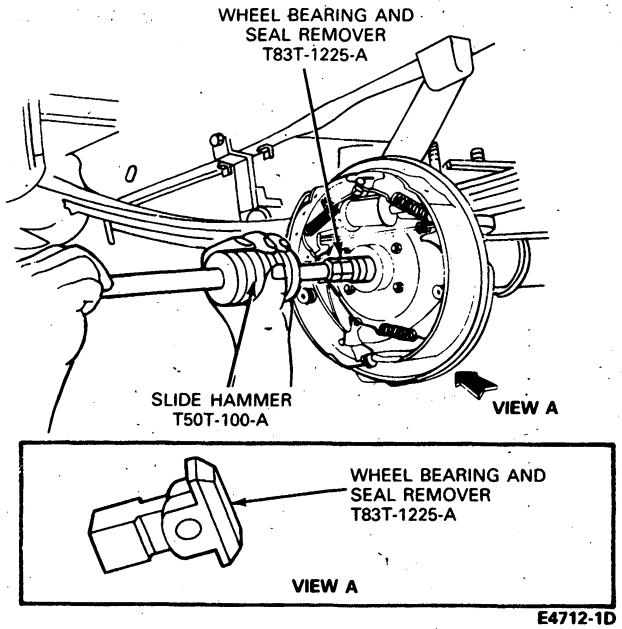


E4760-1B

Oil Seal and Wheel Bearing

Removal

11. Using Slide Hammer, T50T-100-A and Seal Remover, T83T-1225-A or their equivalents insert into the bore as shown and position it behind the bearing so the tangs on the tool engage the bearing outer race. Remove the bearing and seal as a unit, using the slide hammer Tool.



E4712-1D

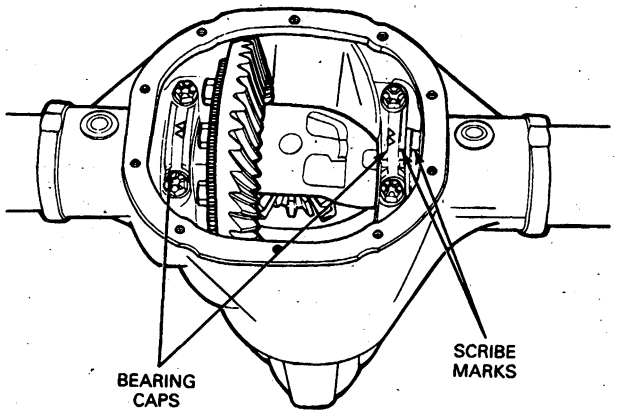
Differential Case

Removal

NOTE: Before removing the differential case, check the ring gear runout as described under Inspection After Disassembly in the Cleaning and Inspection portion of this Section. If ring gear runout exceeds 0.004 inch, the differential case and ring gear must be removed to perform the Differential Runout Check. The Differential Runout Check will isolate the cause of excessive Ring Gear Runout.

12. Mark one differential bearing cap to ensure the caps will be installed in their original positions.

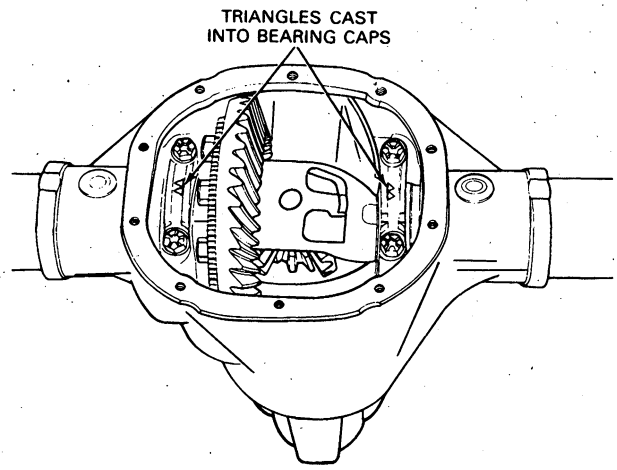
CAUTION: Right and left bearing caps MUST NOT be interchanged.



E4707-1C

13. Loosen the differential bearing cap bolts and bearing caps.

NOTE: The direction of triangles on bearing caps must be noted. When reassembled the triangles must be pointing in the same direction (outboard) as before removal.



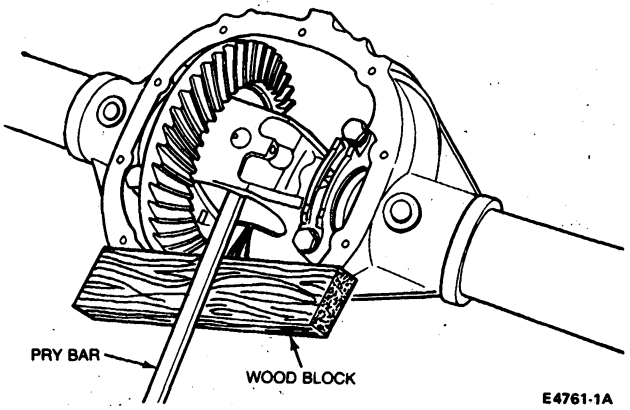
E4763-1B

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DISASSEMBLY AND ASSEMBLY (Continued)

14. Pry the differential case, bearing cups and shims out until they are loose in the bearing caps. Remove the bearing caps and remove the differential assembly from the carrier.

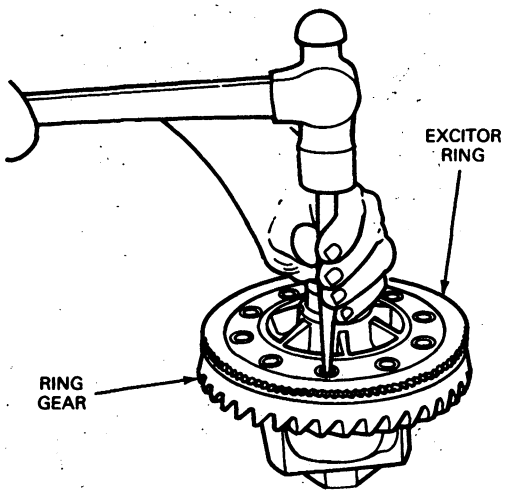
CAUTION: When using the pry bar, place a wood block between the pry bar and the axle housing to protect the carrier face from damage.



Ring Gear

Removal

15. Remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case by striking at alternate holes around the gear.



Excitor Ring

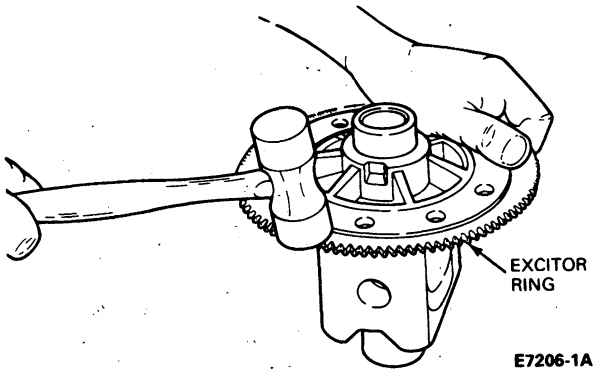
NOTE: While E-150 vehicles are NOT equipped with an excitor ring, the ring gears are removed the same as shown here.

Removal

On vehicles equipped with an excitor ring, first remove the ring gear bolts. As shown above remove ring gear by striking at alternate holes around the gear.

NOTE: The ring gear can be removed and installed without removing the excitor ring.

Remove the excitor ring with a soft faced hammer. Discard excitor ring.



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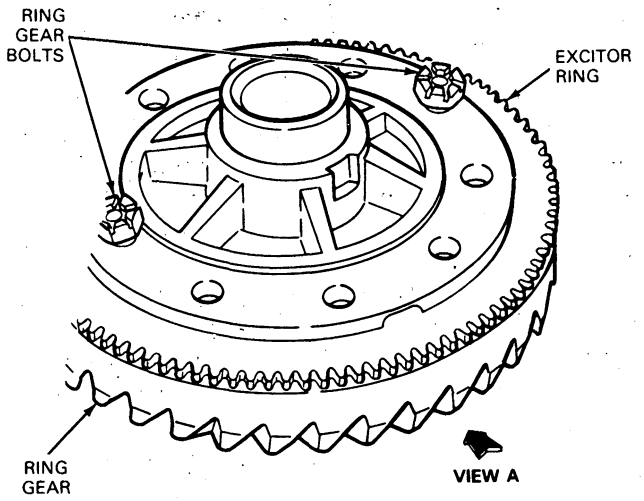
DISASSEMBLY AND ASSEMBLY (Continued)

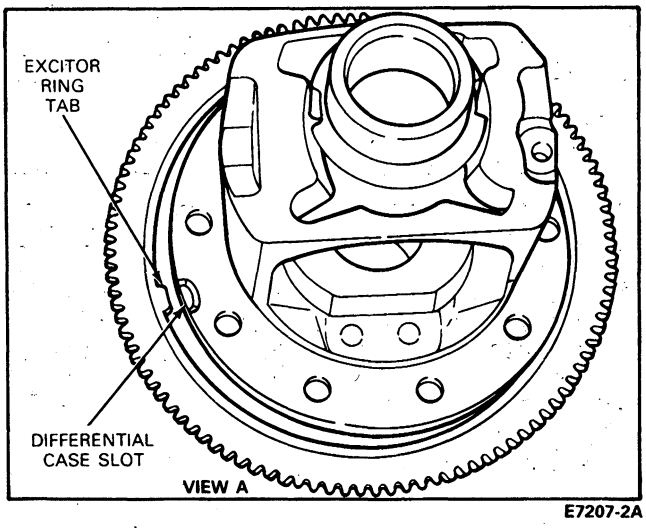
Excitor Ring

Installation

Align tab on excitor ring with slot in differential case. Start two ring gear bolts through the case into the ring gear to ensure case to ring gear bolt hole alignment.

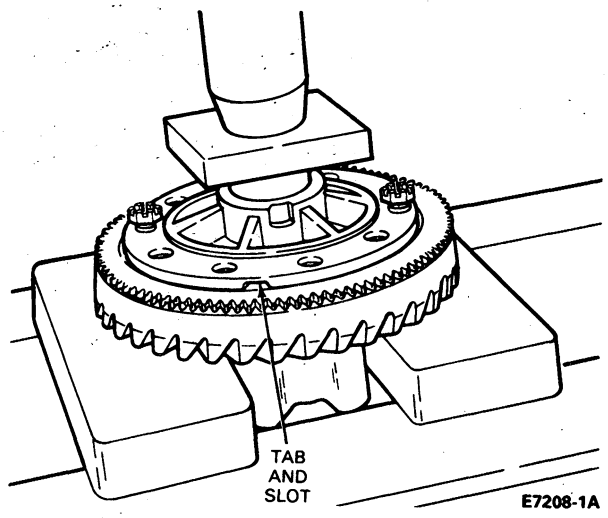
CAUTION: Tab on excitor ring MUST BE aligned with slot in differential case.





Press the excitor ring on the differential case using the ring gear as a pilot. Apply Stud and Bearing Mount E0AZ-19554-BA (ESE-M4G167-A2) or equivalent to ring gear bolts.

Install ring gear bolts and tighten to 95-115 N·m (70-85 ft-lbs).



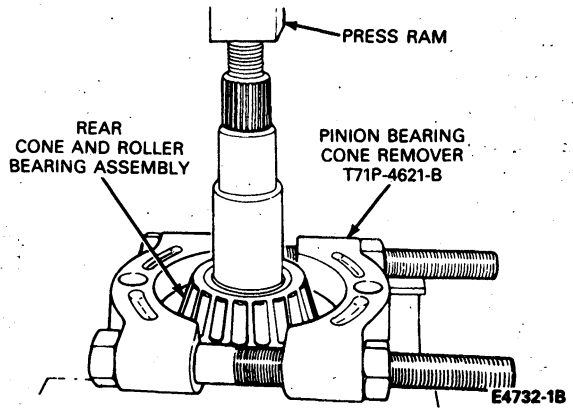
Drive Pinion

Removal

16. With a soft-faced hammer, drive the pinion out of the front bearing cone and remove it through the rear of the carrier.

    To remove the pinion rear cone and roller bearing assembly, use the Pinion Bearing Cone Remover, T71P-4621-B or equivalent as shown.

NOTE: Measure the shim, which is found under the bearing cone, with a micrometer and record the thickness (as a reference to be compared to the shim gauge reading prior to installing the bearing).



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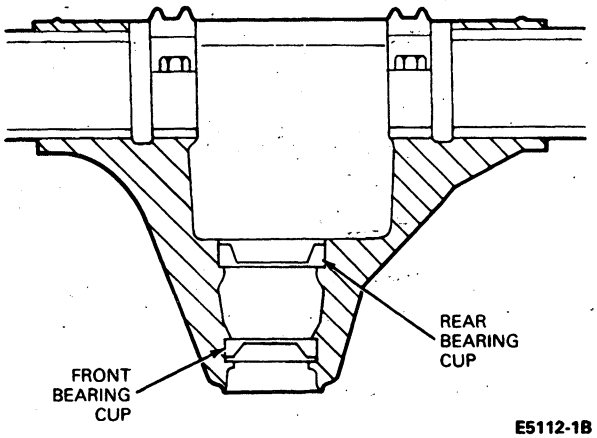
DISASSEMBLY AND ASSEMBLY (Continued)

Pinion Bearing Cup

Removal

NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

17. If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on the opposite side of the cups during removal to prevent cups from cocking in the casting.

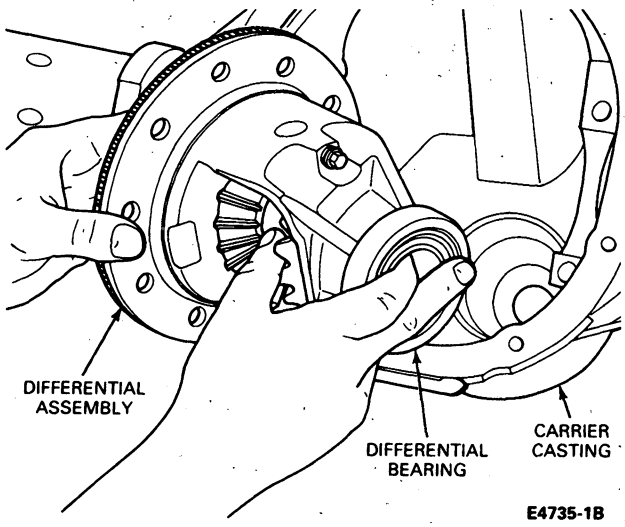


E5112-1B

Differential Runout Check

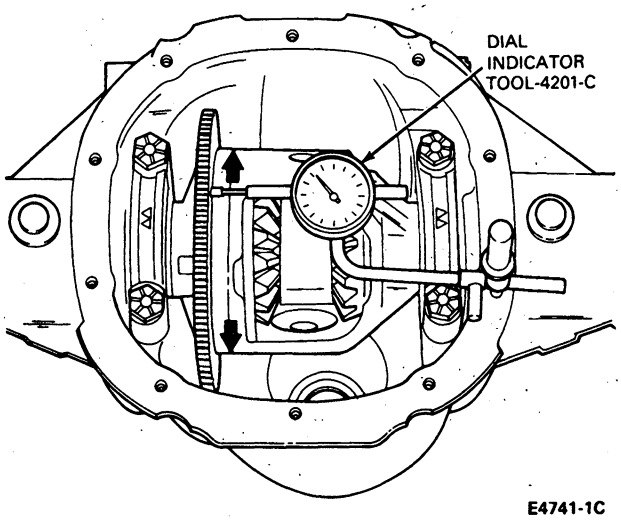
If the ring gear runout check (before disassembly) exceeds specification, the condition may be caused by a warped ring gear, a damaged case, excessively worn differential bearings or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout proceed as follows:

18. Remove the differential case from the axle housing (refer to Differential case and Drive Pinion Removal in this Section) and remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case with a hammer and drift.
19. Install the differential assembly with the bearing cups and shims. Tighten the bearing cup bolts to 95-115 N·m (70-85 ft-lbs.)



E4735-1B

20. Check the runout of the differential case flange with a dial indicator Tool-4201-C. If the runout is within specification, (Max. 0.003 inch), install a new ring and pinion gear. If the runout exceeds specification, the ring gear is true and the concern is due to either a damaged case or bearings. Visually inspect the bearings. If bearings are not damaged replace both the case and bearings. Recheck the runout with new parts (case and bearings). Visually inspect the excitor ring for damage and replace if required.

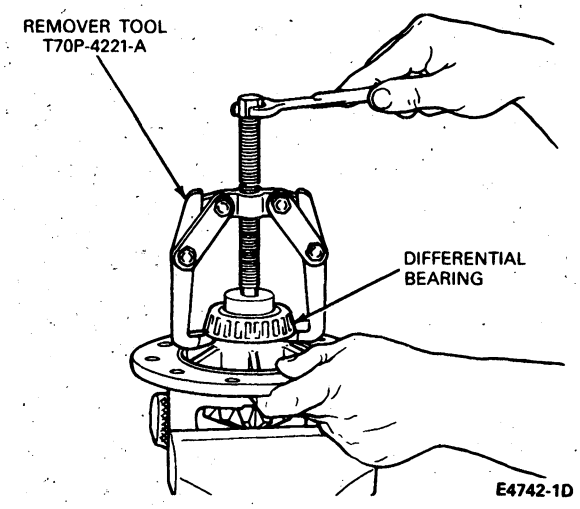


E4741-1C

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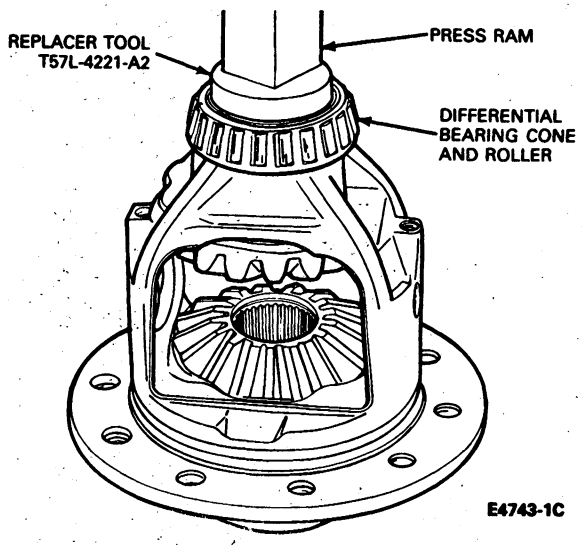
DISASSEMBLY AND ASSEMBLY (Continued)

21. Remove the differential case from the integral carrier and remove the differential bearings from the case using Remover Tool T70P-4221-A or equivalent.

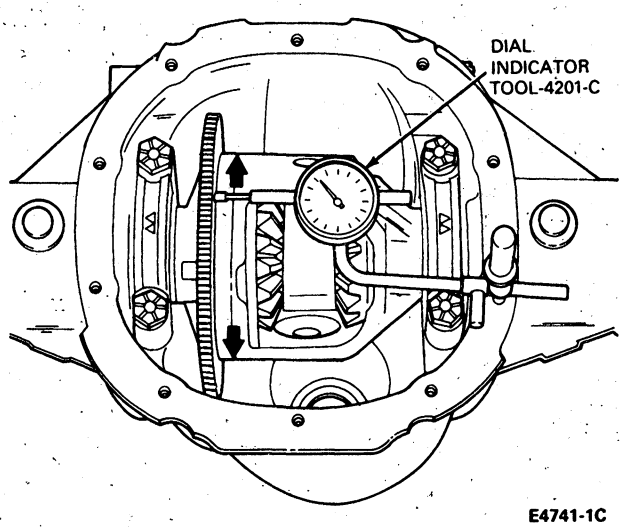


22. Install new differential bearings on the case hubs using Replacer Tool, T57L-4221-A2 or equivalent and install the differential assembly in the carrier without the ring gear.

NOTE: Press against the bearing cone only.



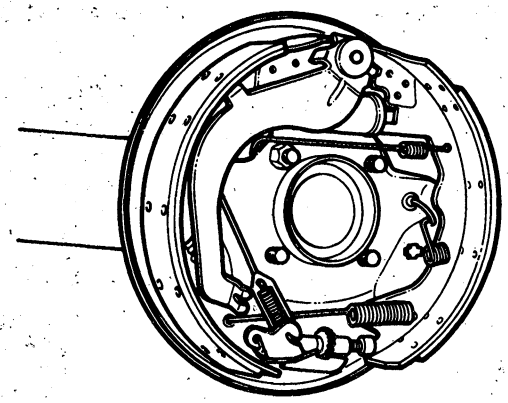
23. Check the case runout again with the new bearings. If the runout is now within 0.076mm (Max. 0.003 inch), use the new bearings for assembly. If the runout is still excessive, the case is damaged and should be replaced.



Axle Housing

Removal

24. Remove the four retaining nuts from each backing plate and wire the backing plate to the underbody.

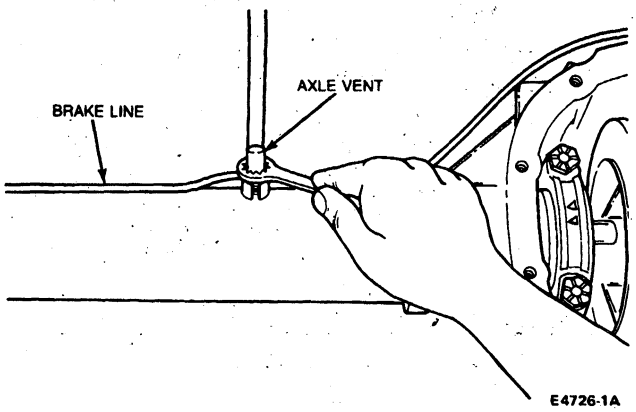


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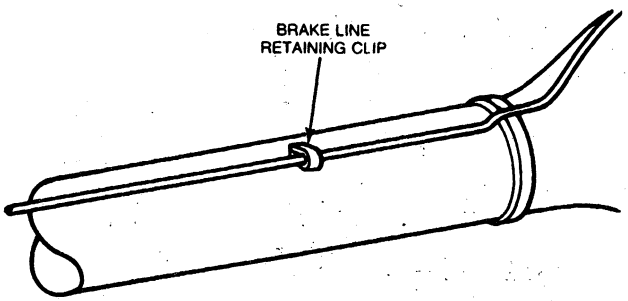
DISASSEMBLY AND ASSEMBLY (Continued)

25. Disconnect the vent hose from the vent and the vent from the rear axle housing.

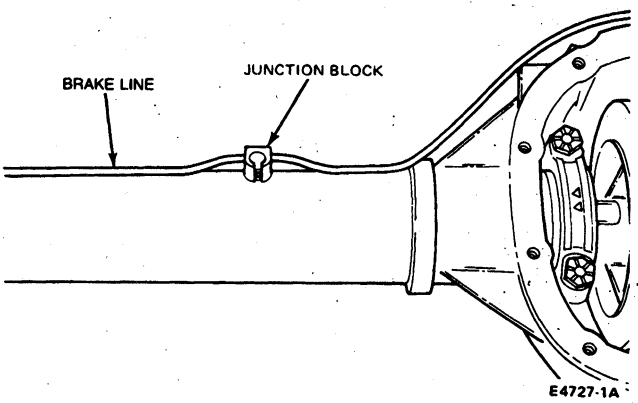
NOTE: The axle vent is secured to the housing assembly through the brake junction block.



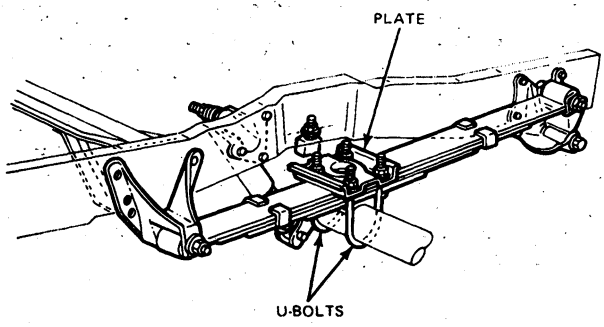
26. Disengage the brake line from the clips that retain the line to the axle housing and carrier.



27. Remove the hydraulic brake junction block from the axle housing. **Do not open the hydraulic brake system lines.**

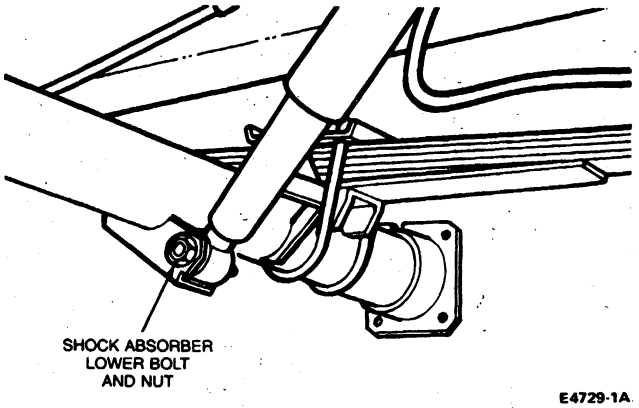


28. Support the rear axle housing on a jack, and then remove the U-bolt nuts. Remove the U-bolts and plates.



29. Disconnect the shock absorber lower bolts from the mounting brackets on the axle housing.

Remove the housing from the vehicle.



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DISASSEMBLY AND ASSEMBLY (Continued)

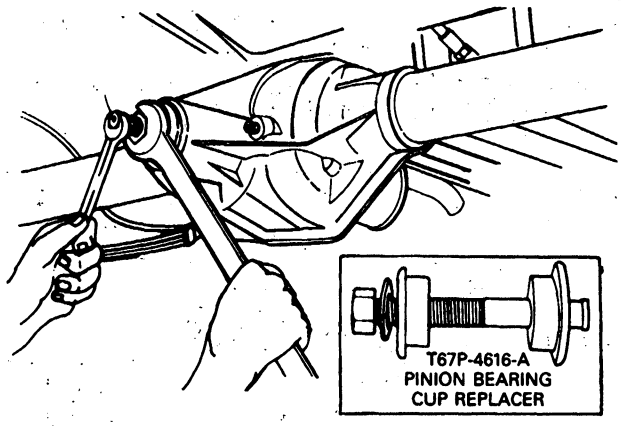
Axle—Assembly

Pinion Bearing Cup

Installation

NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

1. Install the new cups with Pinion Bearing Cup Replacer, T67P-4616-A as shown. Make sure the cups are properly seated in their bores. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup is not properly seated. Whenever the cups are replaced, the cone and roller assembly should also be replaced.



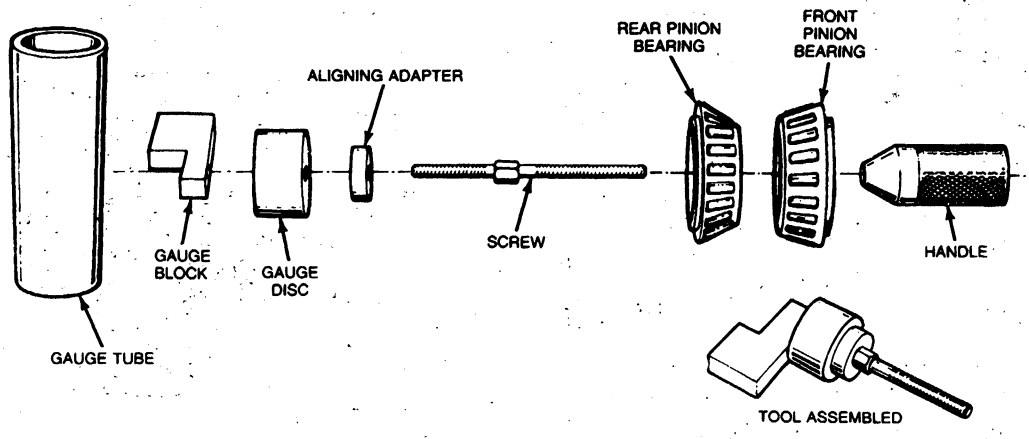
E4733-1B

Drive Pinion Shim Selection

Individual differences in machining the carrier casting and the gear set and variation in bearing widths require a shim between the pinion rear bearing and pinion head, in order to locate the pinion for correct tooth contact with the ring gear.

When replacing a ring and pinion gear, the correct shim thickness for the new gear set to be installed is determined by the following procedure using Pinion Depth Gauge T79P-4020-A.

2. Assemble the appropriate aligning adapter, gauge disc and gauge block to the screw.



REAR AXLE PINION DEPTH GAUGE TOOL

Tool Number*	Description
T76P-4020-A3	Aligning Adapter (1.612" O.D.)
T76P-4020-A9	Screw
T76P-4020-A10	Gauge Block (1.700" thick)
T76P-4020-A11	Handle
T79P-4020-A18	Gauge Disc (1.1884" thick)
T79P-4020-A19	Gauge Tube (3.0630" O.D.)

* The Tool numbers shown in column are part of Tool kit T79P-4020-A.

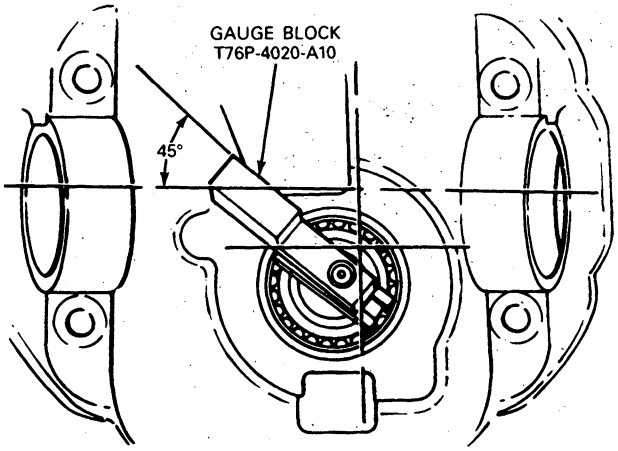
E4744-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

3. Place the rear pinion bearing (new, or used if in good condition) over the aligning tool and insert it into the rear pinion bearing cup of the carrier. Place the front bearing into the front bearing cup and assemble the tool handle into the screw (refer to illustration in Step 4). Roll the assembly back and forth a few times to seat the bearings while tightening the tool handle by hand. Tighten the tool handle to 27 N·m (20 ft-lbs).

NOTE: The gauge block must be offset (45 degrees) to obtain an accurate reading.



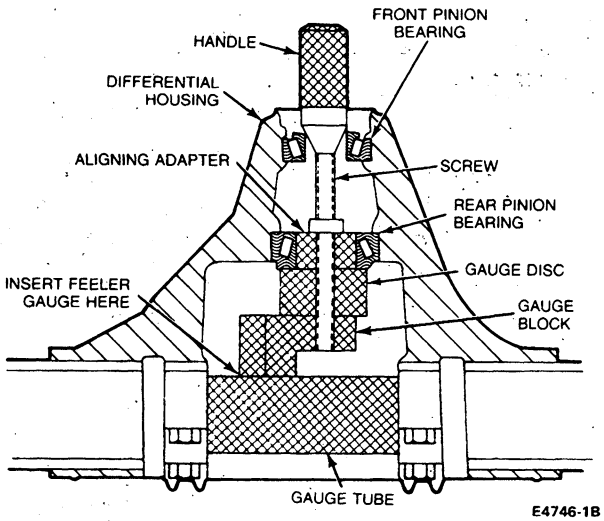
E4745-1B

4. Center the gauge tube into the differential bearing bore. Install the bearing caps and tighten the bolts to 95-115 N·m (70-85 ft-lbs). (Caps are to be installed with the triangles pointing outboard.)

Utilize PINION SHIMS as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness.

NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.

It is important to feel a slight drag on the shim for correct selection. Do not attempt to force the shim between the gauge block and the gauge tube. This will minimize selection of a shim thicker than required, which results in a deep tooth contact in final assembly of integral axles.

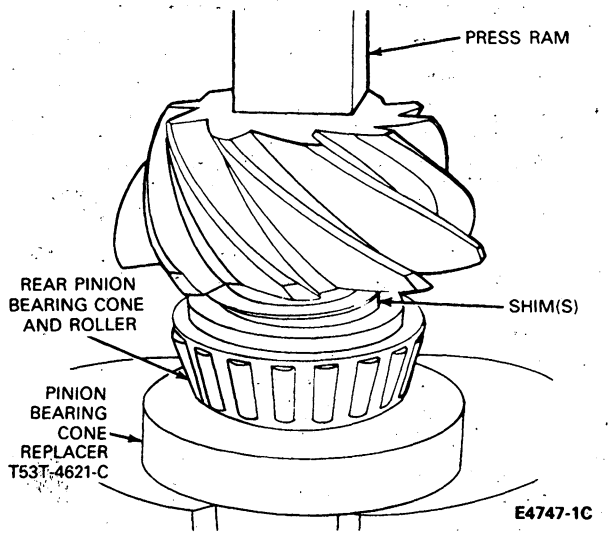


E4746-1B

5. Place the selected shim(s) on the pinion and press the pinion bearing cone and roller assembly until it is firmly seated on the shaft.

NOTE: The same rear pinion bearing used in this procedure must be used in final assembly of the axle.

NOTE: Be sure that press load is not applied to the bearing cage.



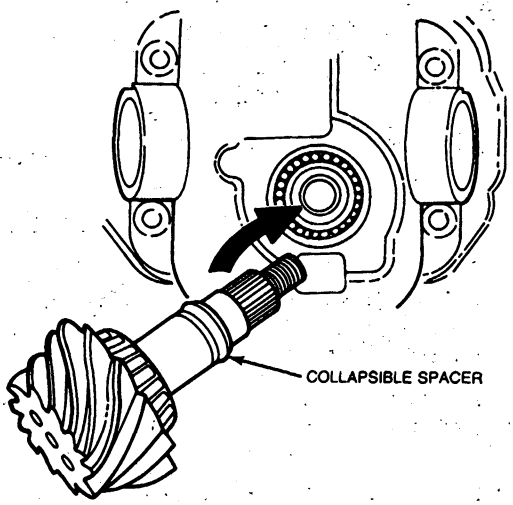
E4747-1C

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DISASSEMBLY AND ASSEMBLY (Continued)

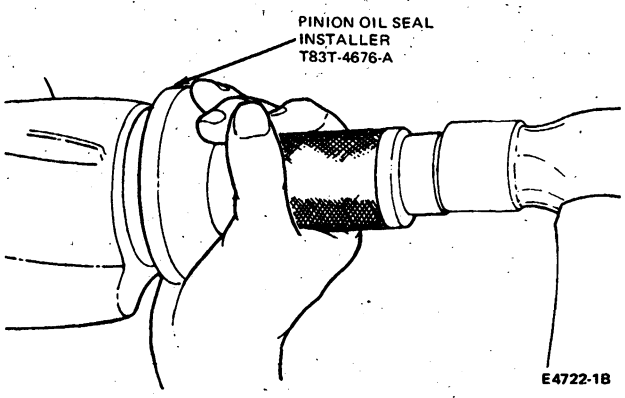
Drive Pinion Installation

6. Check splines on the pinion shaft to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion. Wipe the pinion clean.
7. Place the collapsible spacer on the pinion stem shoulder.
8. From the rear of the axle housing, install the drive pinion assembly (drive pinion, shim(s), rear bearing cone and roller, and collapsible spacer) into the housing pinion bore.



9. Install the front cone and roller, and oil slinger on the pinion.
10. Clean the oil seal seat surface. Install the seal in the carrier using Pinion Oil Seal Installer, T83T-4676-A. Coat the lips of the seal with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



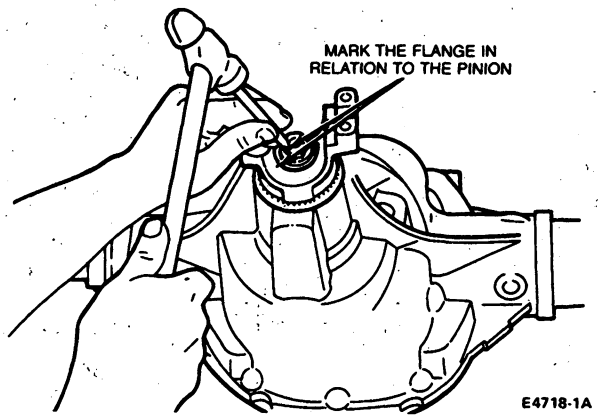
Companion Flange Installation

11. Apply a small amount of lubricant to the companion shaft splines. Align the mark on the companion flange with the mark on the pinion shaft. Install the flange.

    Install a new pinion nut on the pinion stem.

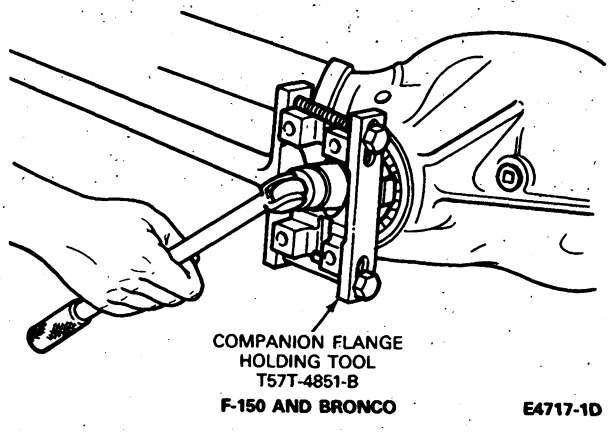
NOTE: If a new companion flange is being installed, disregard the scribe mark on the pinion shaft.

NOTE: The companion flange must never be hammered on or installed with power tools.



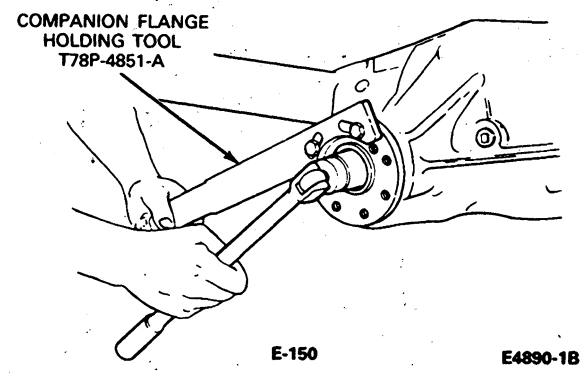
12. For F-150 and Bronco hold the half-round companion flange with Companion Flange Holding Tool, T57T-4851-B or equivalent while tightening the pinion nut (see Step 13).

For E-150 hold the circular companion flange with Companion Flange Holding Tool, T78P-4851-A or equivalent while tightening the pinion nut (see Step 13).



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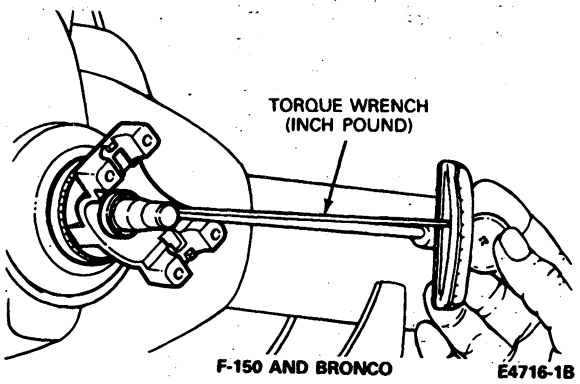
DISASSEMBLY AND ASSEMBLY (Continued)

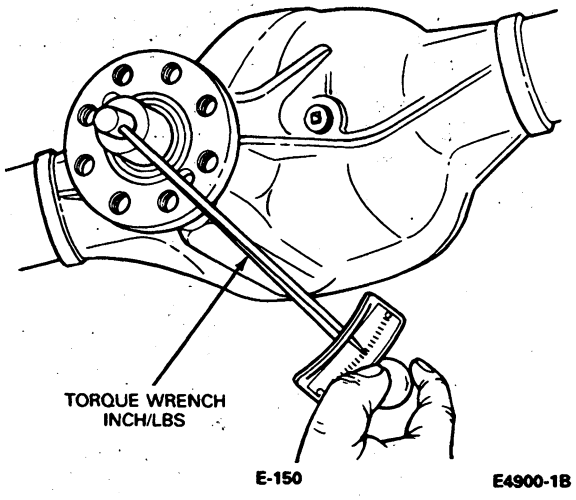


13. Tighten the pinion nut to a minimum torque of 217 N·m (160 ft-lbs), rotating the pinion occasionally to insure proper bearing seating. Take frequent drive pinion bearing torque preload readings until the original recorded preload reading is obtained.

    If the original recorded preload is lower than specification (used bearings .9-1.5 N·m [8-14 in-lbs]; new bearings 1.8-3.3 N·m [16-29 in-lbs]) tighten to specification. If the preload is higher than specification, tighten to original reading as recorded.

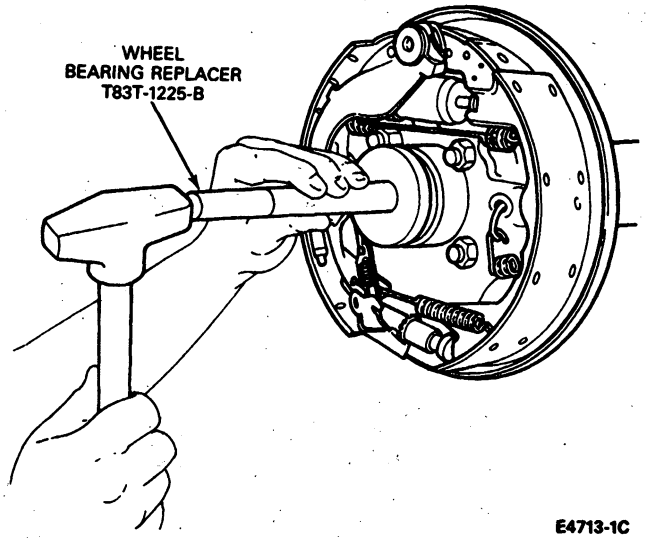
    Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.





Wheel Bearing and Oil Seal Installation

14. Lubricate the new bearing with rear axle lubricant and install the bearing into the housing bore using Axle Bearing Replacer T83T-1225-B or equivalent.

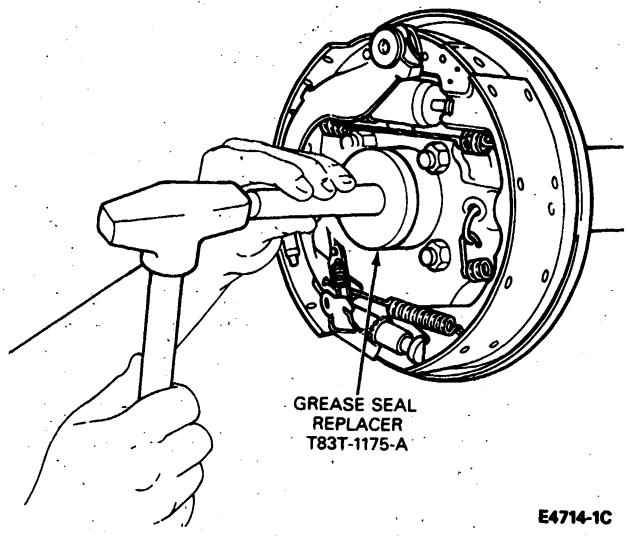


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DISASSEMBLY AND ASSEMBLY (Continued)

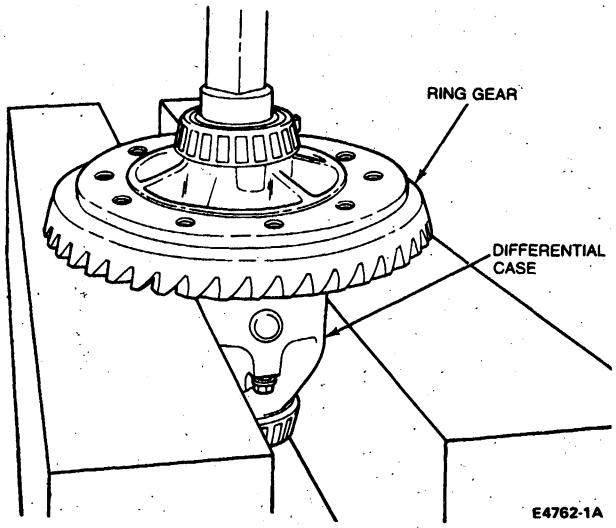
15. Coat the lips of the seal with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent and install the axle shaft seal using Grease Seal Replacer T83T-1175-A.

CAUTION: Installation of the bearing or seal assembly without the proper tool may result in an early bearing or seal failure. If seal becomes cocked in the bore during installation, remove it and install a new one.



E4714-1C

17. Press on the NEW excitor ring and ring gear if removed onto the differential case. Refer to procedure in this Section. Apply Stud and Bearing Mount E0AZ-19554- BA (ESE-M4G167- A2) or equivalent to ring gear bolts and install. Tighten the bolts to 95-115 N·m (70-85 ft-lbs).



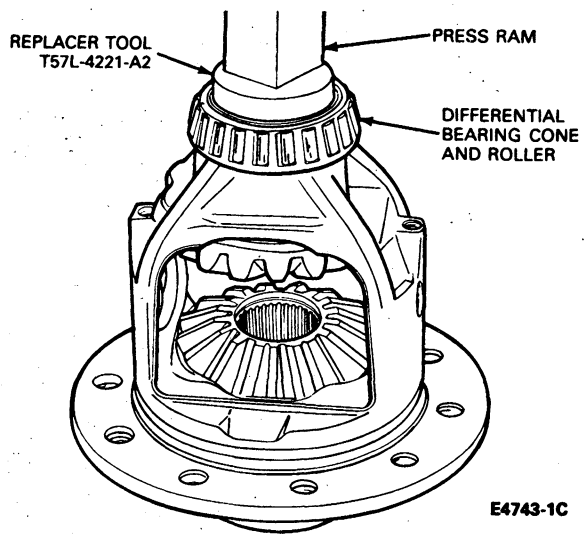
E4762-1A

Differential Case

Installation

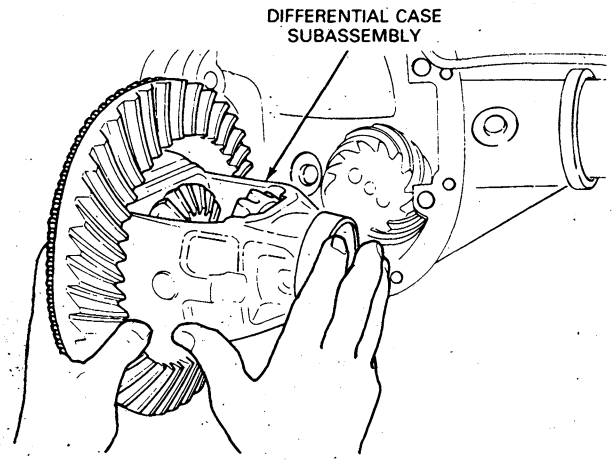
16. Install differential bearings on the case hubs using Differential Side Bearing Replacer, T57L-4221-A2 or equivalent.

NOTE: Press against the bearing cone only.



E4743-1C

18. With pinion depth set and pinion installed, place differential case subassembly (with ring gear, excitor ring, thrust washers, side gears, bearings and cups) in carrier.

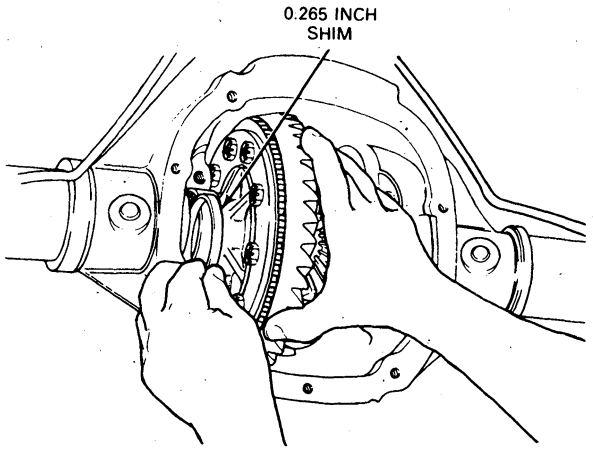


E4749-1B

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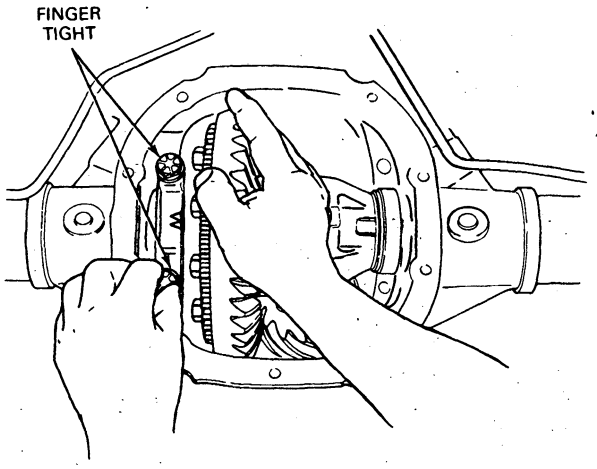
DISASSEMBLY AND ASSEMBLY (Continued)

19. Install a 0.265 inch shim on left side.



E4750-1C

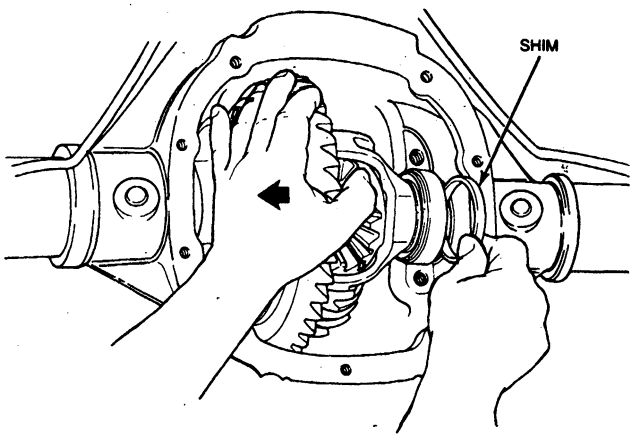
20. Install left bearing cap and tighten bolts finger tight.



E4751-1B

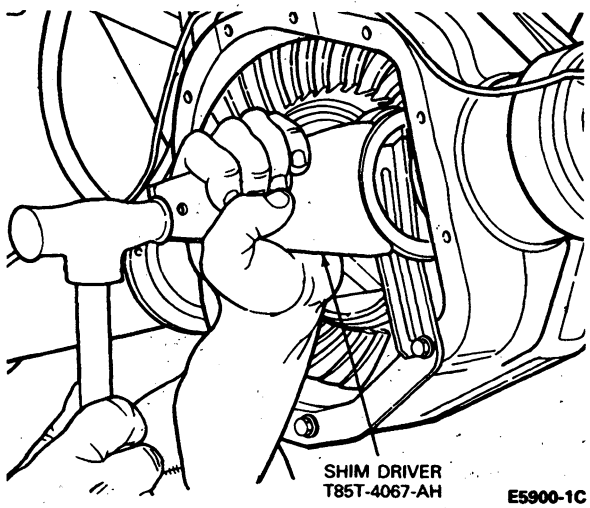
21. Install progressively larger shims on the right side until the largest shim selected can be assembled with a slight drag feel.

NOTE: Apply pressure towards left side to insure that the left bearing cup is seated.



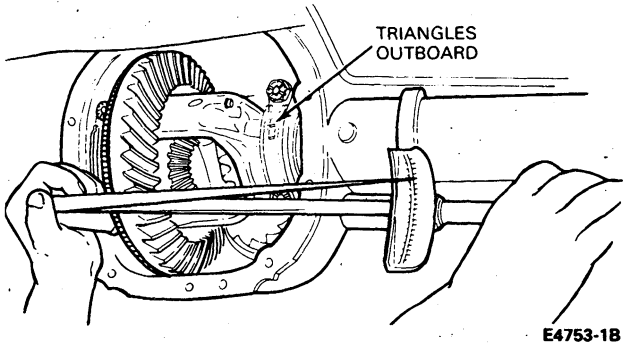
E4752-1A

22. Install the rest of the shims by driving into position with Shim Driver, T85L-4067-AH.



E5900-1C

23. Install right side bearing cap and tighten bearing cap bolts to 95-115 N·m (70-85 ft-lbs).

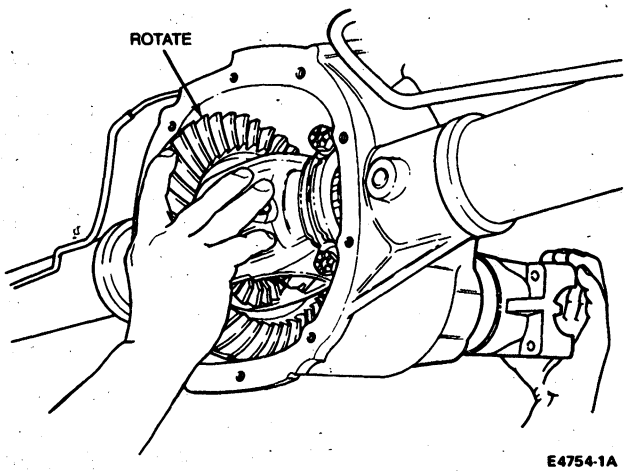


E4753-1B

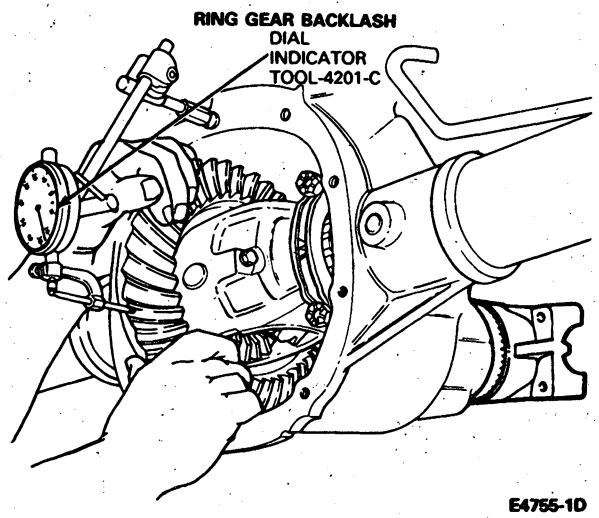
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DISASSEMBLY AND ASSEMBLY (Continued)

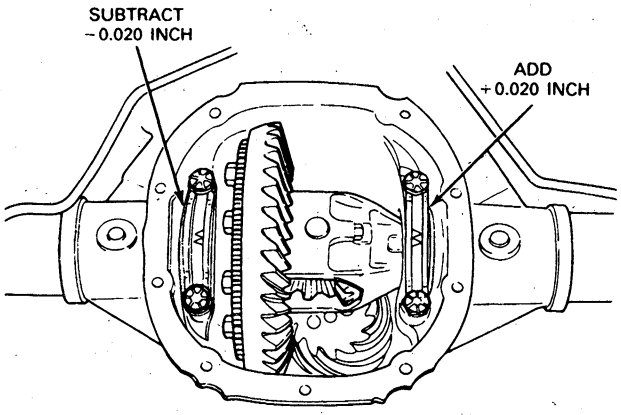
24. Rotate assembly to insure free rotation.



25. Check ring gear and pinion backlash. If the backlash is 0.008 inch to 0.015 inch (0.012 inch to 0.015 inch preferred) proceed to Step 32. If the backlash is zero, go to Step 26. If the backlash is not zero, but is less than 0.008 inch, or more than 0.015 inch, then go to Step 28.

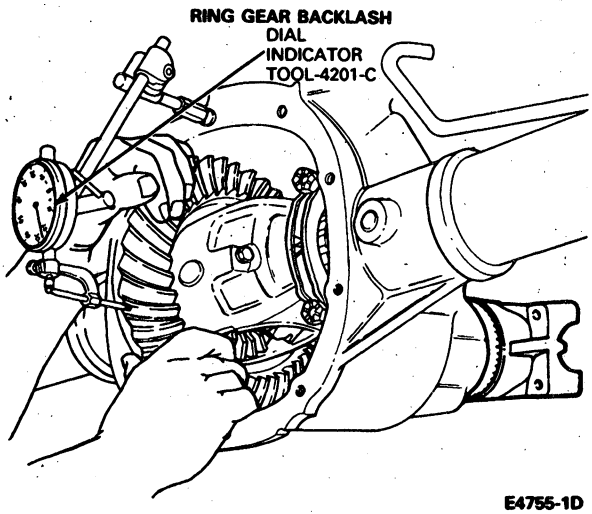


26. If a zero backlash condition occurs, add 0.020 inch to the right side and subtract 0.020 inch from the left side to allow for a backlash reading.



27. Recheck backlash. See Step 28, if backlash is not within specification. Backlash specification: 0.008 inch to 0.015 inch. Preferred range: 0.012 inch to 0.015 inch.

    If backlash is within specification, go to Step 29.



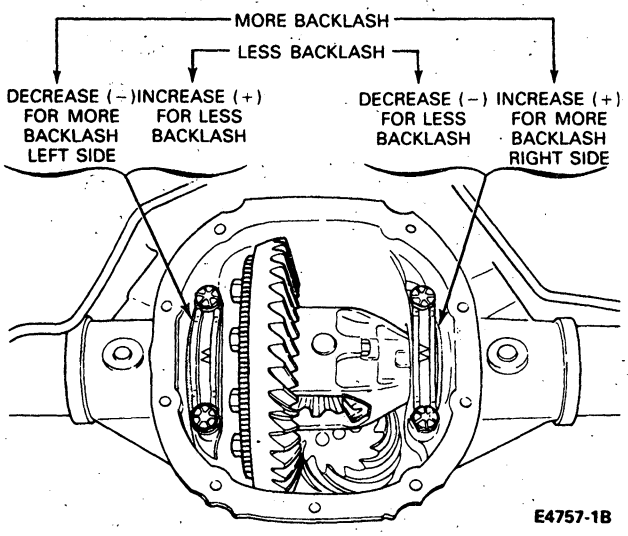
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DISASSEMBLY AND ASSEMBLY (Continued)

28. If backlash is not to specification, correct backlash by increasing thickness of one shim and decreasing thickness of the other shim by the same amount. Refer to chart for approximate shim change.

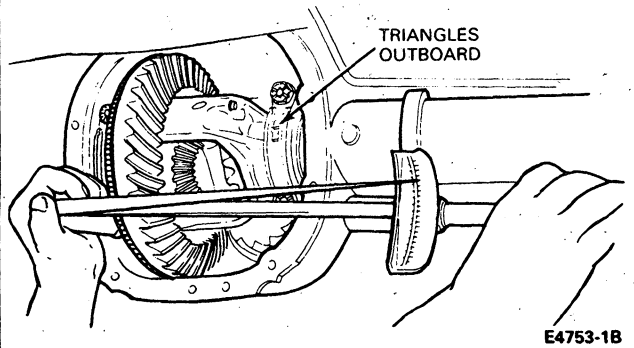
Backlash Change Required	Thickness Change Required	Backlash Change Required	Thickness Change Required
.001	.002	.009	.012
.002	.002	.010	.014
.003	.004	.011	.014
.004	.006	.012	.016
.005	.006	.013	.018
.006	.008	.014	.018
.007	.010	.015	.020
.008	.010		

CE5113-1A



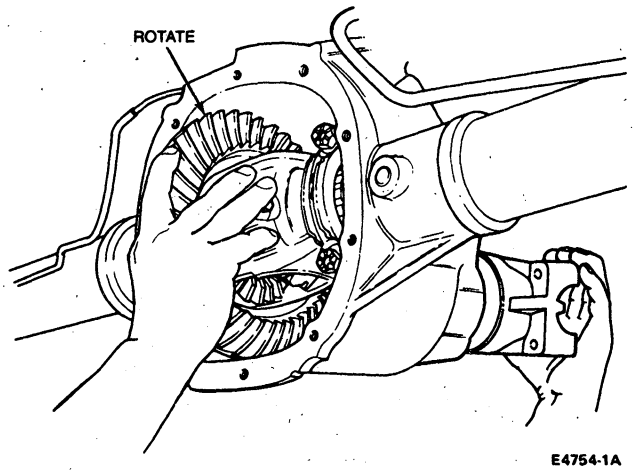
E4757-1B

29. Install shim and bearing caps. Tighten cap bolts to 95-115 N·m (70-85 ft-lbs).



E4753-1B

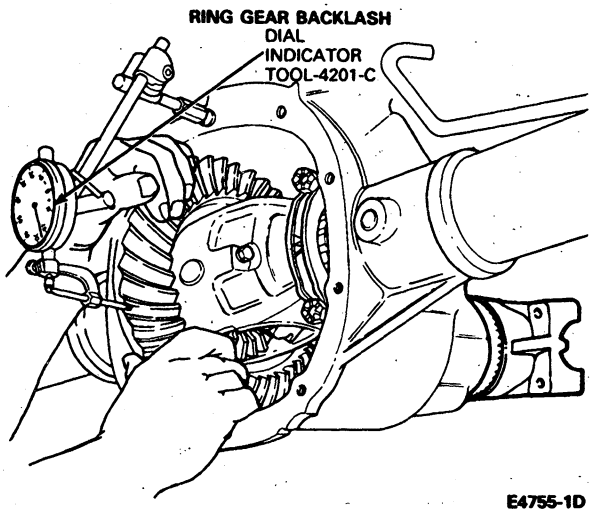
30. Rotate assembly several times to insure proper seating of differential bearings.



E4754-1A

31. Recheck backlash. If backlash is within specification, go to Step 32. If backlash is not within specification, repeat Step 28.

Backlash Specification: 0.008 inch to 0.015 inch. Preferred range: 0.012 inch to 0.015 inch.

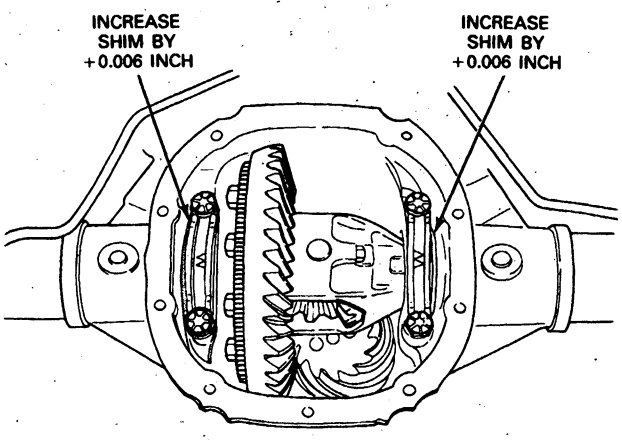


E4755-1D

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DISASSEMBLY AND ASSEMBLY (Continued)

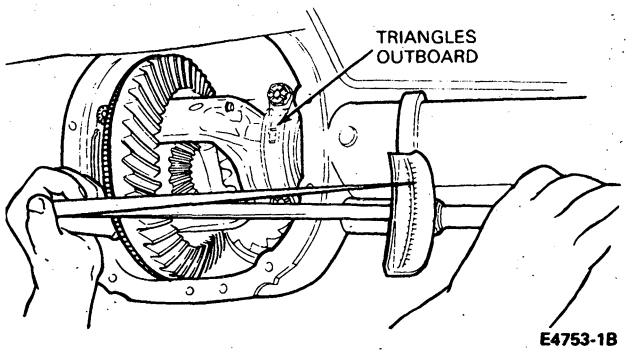
32. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.006 inch. Make sure shims are fully seated and assembly turns freely.



E4758-1D

33. Install bearing caps and tighten cap bolts to 95-115 N·m (70-85 ft-lbs). Recheck backlash. If not to specification, repeat Step 28.
34. Utilize white marking compound to obtain a tooth mesh contact pattern in your assembly. Pattern legibility can be improved by connecting the driveshaft and rotating both tires in drive and coast direction.

    Reincorporation of pattern inspection is intended to allow technician the ability to detect gross errors in set-up prior to complete reassembly. Pattern contact should be within the primary area of the ring gear tooth surface avoiding any "narrow" or "hard" contact with outer perimeter of tooth (top to root, toe to heel). Pattern inspection should be on the drive (pull) side. Assembly with correct drive pattern will result in satisfactory coast performance. If gross pattern error is detected, with preferred backlash (0.012 inch-0.015 inch), recheck pinion shim selection.



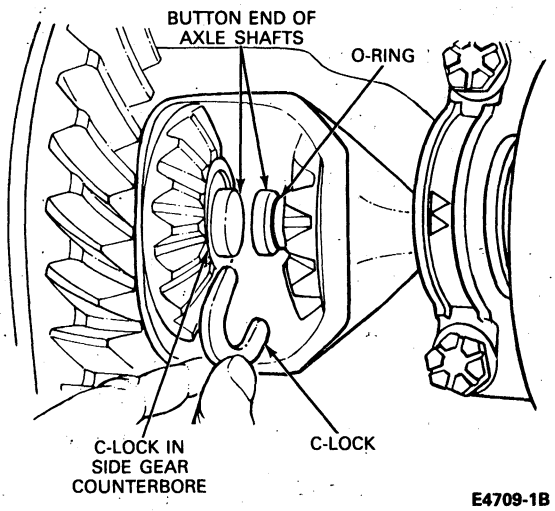
E4753-1B

Axle Shaft

Installation

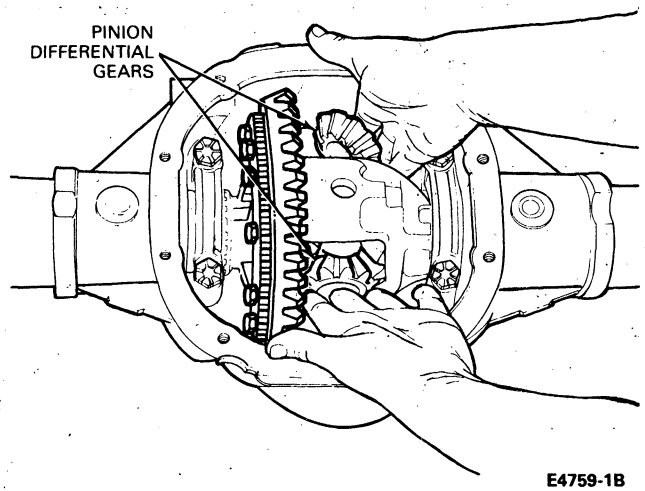
35. Slide the axle shafts into place in the axle housing. Exercise care so that the splines or any portion of the axle shafts do not damage the oil seals. Push the shafts inboard enough to allow installation of the C-lock.
2. Install the axle shaft C-locks on the button end of the axle shafts and push the shafts outboard so that the shaft lock seats in the counterbore of the differential side gar.

NOTE: A rubber O-ring is used to hold the C-lock in position on the axle shaft. Be sure that the O-ring is in the groove at the button end of the axle shaft before installing the C-lock.



E4709-1B

36. Position the differential pinion gears and thrust washers (180 degrees apart) to the differential side gears. Turn the gear assembly to move the pinion gears and thrust washers into the proper position in the differential case (washer and pinion gear bores aligned with pinion shaft holes in case).

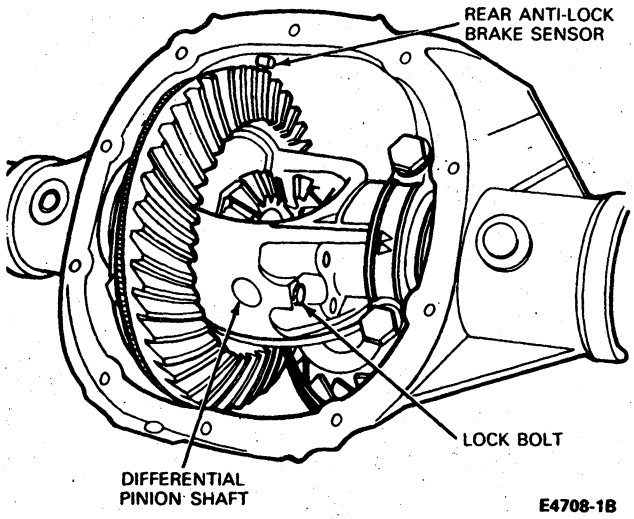


E4759-1B

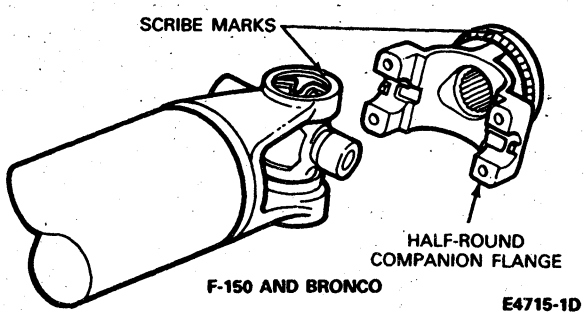
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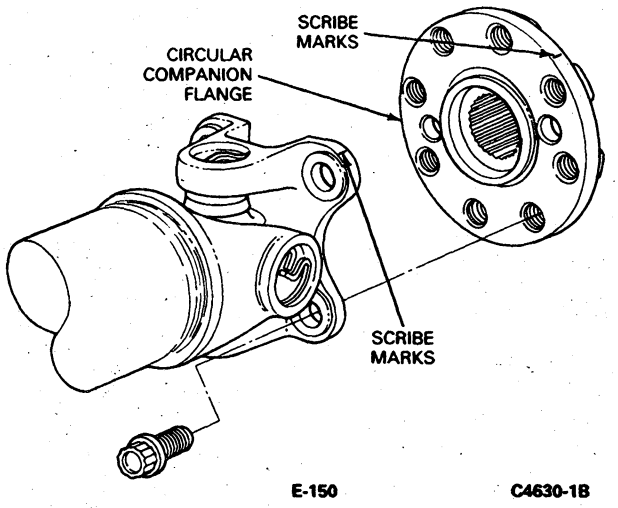
DISASSEMBLY AND ASSEMBLY (Continued)

37. Position the differential pinion shaft through the case and pinions, aligning the hole in the shaft with the lock bolt hole. Apply Stud and Bearing Mount, E0AZ-19554-B (ESE-M4G167-A2) or equivalent to the lock bolt threads. Install lock bolt and tighten to 20-40 N·m (15-30 ft-lbs).



38. Remove the oil seal replacer from the transmission extension housing. Install the driveshaft in the extension housing. Align the scribe marks on the flange and driveshaft and connect the driveshaft at the axle companion flange. Tighten attaching bolts and nuts to companion N·m (8-15 ft-lbs) for half round companion flange and 95-128 N·m (70-95 ft-lb) for circular companion flange.





39. Install the brake drums.

    Install the wheels and tires. Tighten the wheel lug nuts to specification. Install the wheel covers.

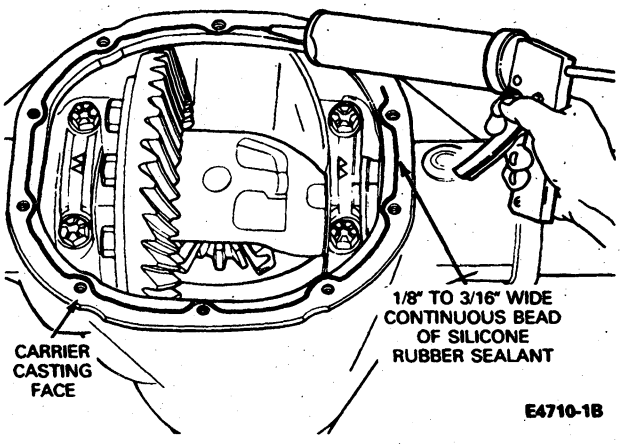
Rear Cover

Installation

40. Clean the gasket mating surface of the rear axle carrier casting and cover.

    Apply a new continuous head of Silicone Rubber, D6AZ-19562-AA or -BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to the carrier casting face inside the cover bolt holes

CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.

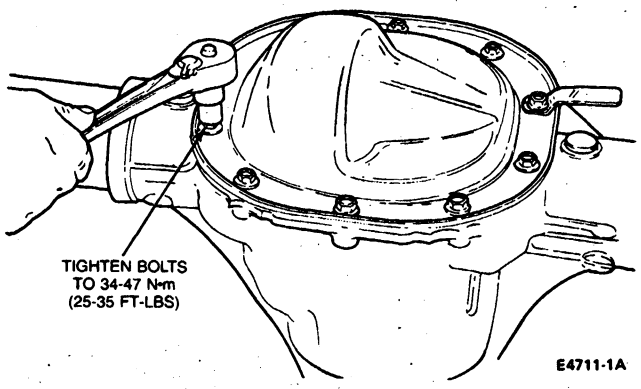


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DISASSEMBLY AND ASSEMBLY (Continued)

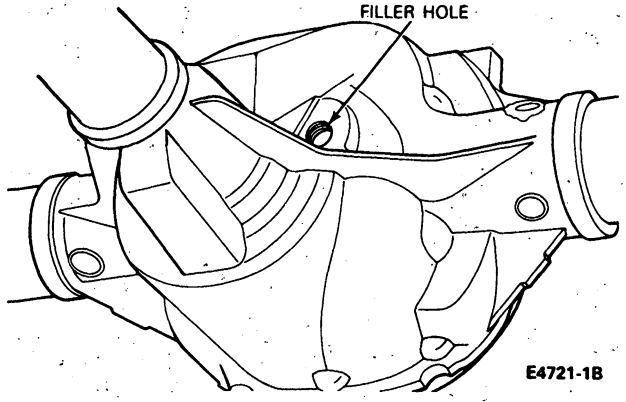
41. Install cover and tighten cover bolts to 34-47 N·m (25-35 ft=lbs) as shown. Tighten the cover bolts in a cross-wise pattern to insure uniform draw on cover.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.



42. Add lubricant through the filler hole until the lubricant level reaches the bottom of the filler hole with the axle in the running position. For axles with conventional differentials, use Hypoid Gear Lubricant (SAE 90) E0AZ-19580-A (ESP-M2C154-A) lubricant or equivalent. Install the filler plug and tighten to 20-40 N·m (15-30 ft-lb).

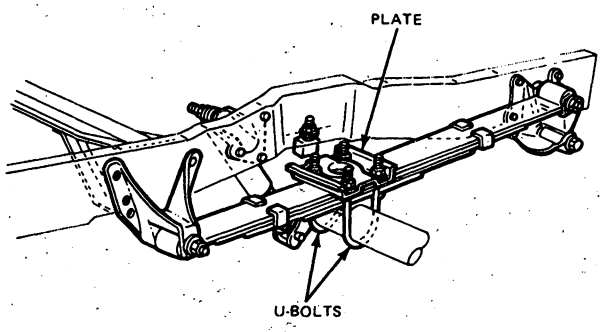
Lower vehicle and road test.



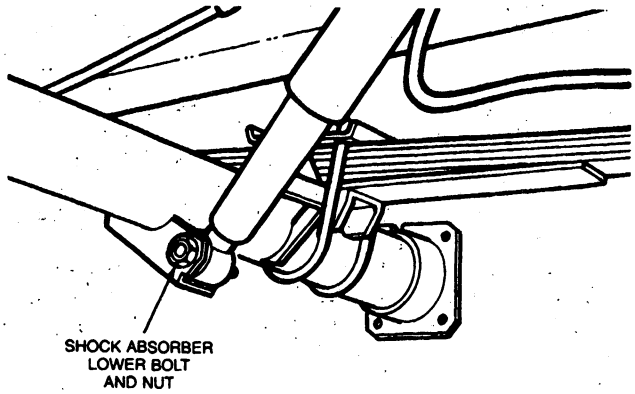
Axle Housing

Installation

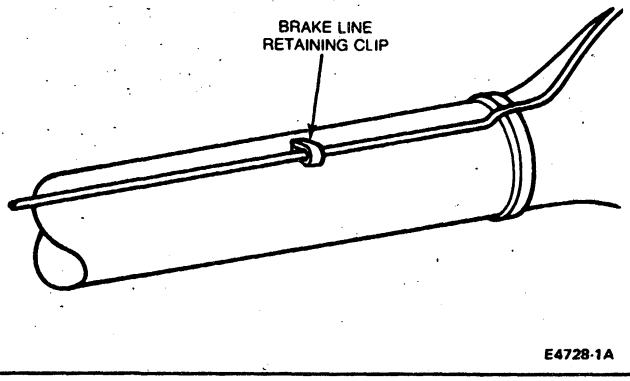
43. Raise the axle housing into position so that the U-bolt plates can be installed. Tighten the U-bolts to the specification listed in Section 14-31, Rear Suspension—Leaf Springs. (There are different specifications, depending on the vehicle).



44. Connect the shock absorber lower bolts to the mounting bracket on the axle housing. Install the attaching nuts and tighten to the specification listed in Section 14-31, Rear Suspension—Leaf Springs.



45. Insert the vent fitting into the hydraulic junction block and position the assembly over the housing vent hole. Hand start the vent fitting and tighten.

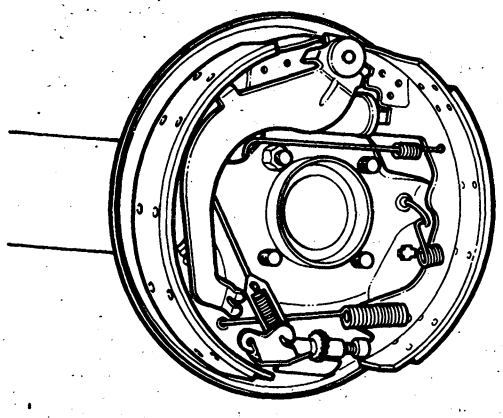


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DISASSEMBLY AND ASSEMBLY (Continued)

46. Position the brake lines to the axle housing and secure with the retaining clips at the right hand axle tube and vent fitting through the junction block.

    Install the brake backing plates on the axle housing flanges (no gaskets required). Tighten the attaching nuts to 28-54 N·m (20-40 ft-lbs).



E4725-1A

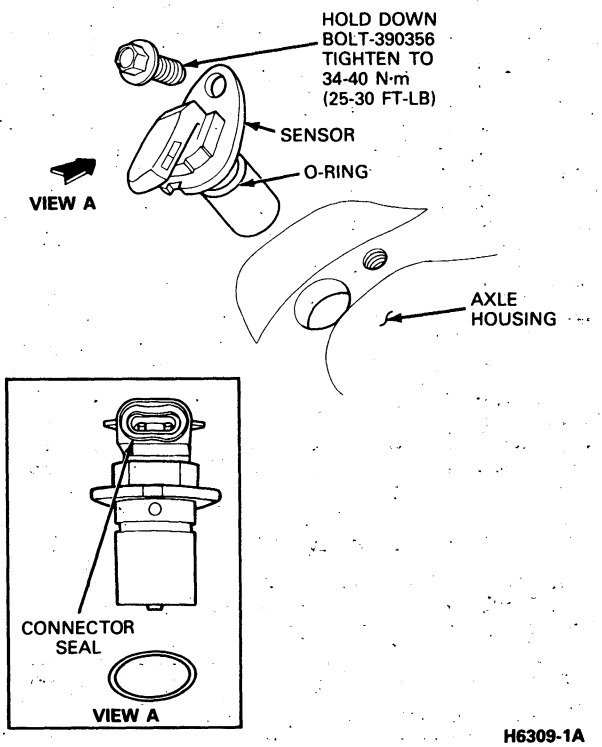
Rear Antilock Brake System Sensor (F-150 and Bronco only)

Removal

1. Remove sensor hold down bolt. Remove sensor.
2. Clean axle mounting surface, using caution to prevent dirt from entering axle housing.

Installation

1. If new sensor is to be installed, lightly lubricate O-ring with motor oil.
   a. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
   b. Install hold down bolt and tighten to 34-41 N-m (25-30 ft-lb).
2. If old sensor is to be reinstalled, clean and blow off metal particles using shop air.
   a. Remove and replace O-ring with a new O-ring.
   b. Apply a light film of motor oil to O-ring.
   c. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
   d. Install hold down bolt and tighten to 34-41 N·m (25-30 ft-lb).



H6309-1A

SPECIFICATIONS

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — CONVENTIONAL

Description	Torque (In-Lb) N·m	Torque (Ft-Lb) N·m
Approximate torque required to tighten pinion flange nut to obtain correct pinion bearing preload	—	(160) ① 217
Pinion Bearing Preload — (Collapsible Spacer) ②		
Used Bearings — 8.8 inch	(8-14) .9-1.5	—
New Bearings — 8.8 inch	(16-29) 1.8-3.3	—

①If pinion bearing preload exceeds specification before this torque is obtained, install a new collapsible spacer.

②With oil seal.

CE5117-1C

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SPECIFICATIONS (Continued)

DRIVING AXLE IDENTIFICATION (INTEGRAL CARRIER) — CONVENTIONAL

Identification Tag	Ratio	Ring Gear Diameter (Inches)	Differential Type
720C	3.08:1	8.8	C2
724S	3.55:1	8.8	C2
730D	3.55:1	8.8	C2
806E	3.08:1	8.8	C2
808E	3.55:1	8.8	C2
812E	2.73:1	8.8	C2
814E	3.55:1	8.8	C2

CE5116-1F

CLEARANCE, TOLERANCE AND ADJUSTMENTS (INTEGRAL CARRIER)

Description	Inches
Maximum Runout of Back Face of Ring Gear	0.004
Maximum Runout of Back Face of Differential Case Flange	0.003
Differential Side Gear Thrust Washer Thickness	0.030-0.032
Differential Pinion Gear Thrust Washer Thickness	0.030-0.032
Nominal Pinion Locating Shim	0.030
Available Pinion Gear Shims in Steps of 0.001 Inch	0.021-0.037
Backlash Between Ring Gear & Pinion Teeth	0.008-0.015 (0.012-0.015 Preferred)
Maximum Backlash Variation Between Teeth	0.004
Maximum Radial Runout of Companion Flange in Assembly	0.012 T.I.R.
Sensor Pole to Top of Exciter Ring Gap	0.005-0.045

CE5118-1C

TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — CONVENTIONAL

Description	Torque	
	N-m	Ft-Lbs
Differential Bearing Cap Bolt — Inch	95-115	70-85
Differential Pinion Shaft Lock Bolt ①	20-40	15-30
Ring Gear Attaching Bolts — Inch ①	95-115	70-85
Rear Cover Screw	34-47	25-35
Oil Filler Plug	20-40	15-30
Axle Vent	20-34	15-25
Brake Backing Plate Nuts	28-54	20-40
Driveshaft to Axle Circular Companion Flange Attaching Bolts — E-150	95-128	70-95
Driveshaft to Axle Half-Round Companion Flange Attaching Bolts-F-150 and Bronco②	10-20	8-15

①Using Loctite E0AZ-19554-B (or equivalent).
②See Step 38 for Half-Round Type Companion Flange.

CE5119-1D

SPECIAL SERVICE TOOLS

Tool Number	Description
T50T-100-A	Impact Slide Hammer
T58L-101-B	Puller Attachment
T83T-1225-A	Grease Seal Remover (Use with Slide Hammer T50T-100-A)
T83T-1175-A	Grease Seal Replacer
T83T-1225-B	Axle Bearing Replacer
T85L-4067-AH	Differential Shim Driver
TOOL-4201-C	Differential Backlash and Runout Gauge with Universal Bracket
TOOL-4201-D	Dial Indicator Tip 1/4 Inch
T57L-4220-A2	Differential Side Bearing Remover
T79P-4020-A	Pinion Depth Gauge
T57L-4221-A	Differential Side Bearing Replacer
T70P-4221-A	Differential Side Bearing Remover
T68P-4602-A	Pinion Angle Level Gauge
T68P-4602-AA	Frame
T68P-4602-AB	Vial
T68P-4602-AC	Magnet
T60K-4616-A	Pinion Bearing Cups Replacer (Inner and Outer)
T67P-4616-A	Pinion Bearing Cups Replacer
T71P-4616-A	Pinion Bearing Cup Replacer
T53T-4621-C	Pinion Bearing Cone Replacer
T71P-4621-B	Pinion Bearing Cone Replacer
T83T-4676-A	Pinion Seal Replacer
T65L-4851-B	Companion Flange Remover
T57T-4851-B	Companion Flange Holding Tool — Half-Round Flange
T78P-4851-A	Companion Flange Holding Tool — Circular Flange

CE5115-1F

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SPECIFICATIONS (Continued)

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER) — CONVENTIONAL

Vehicle	Engine	Axle	Approximate Lubricant Capacity ①			Lubricant Level ②
			U.S. Pints	Imperial Pints	Liters	
F-150	All	8.8 Inch Ring Gear	5.50	4.58	2.60	0.2 inch
Bronco	All	8.8 Inch Ring Gear	5.50	4.58	2.60	0.6 inch
E-150	All	8.8 Inch Ring Gear	5.50	4.58	2.60	0.2 inch

①All conventional and Traction-Lok Axles use Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent plus 4 ounces of friction modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent for complete refill of Traction-Lok Rear Axles.
②Below bottom of filler plug hole with vehicle in running position plus or minus 1/8 inch.

CE5120-2D

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SECTION 15-09 Integral Carrier Axle—Ford 10.25 Inch Ring Gear

SUBJECT	PAGE
CLEANING AND INSPECTION	
Bearing Cups	15-09-7
Carrier Housing	15-09-7
Companion Flange	15-09-7
Cone and Roller Assemblies	15-09-7
Differential Case	15-09-7
Gears	15-09-7
Inspection After Disassembly	15-09-6
Inspection Before Disassembly	15-09-6
DESCRIPTION AND OPERATION	
Description	15-09-1
Operation	15-09-3
Rear Antilock Brakes	15-09-2
DISASSEMBLY AND ASSEMBLY	
Differential Case	15-09-35
Hub—Full Floating Axle Only	15-09-35
REMOVAL AND INSTALLATION	
Axle Housing	15-09-33

SUBJECT	PAGE
REMOVAL AND INSTALLATION (Cont'd.)	
Axle Shaft, Hub, Oil Seal and Outer Wheel Bearing	15-09-11
Full Floating Axle	15-09-11
Axle Shaft—Semi-Floating Axle	15-09-8
Differential Case and Drive Pinion	15-09-17
Removal	15-09-17
Differential Runout Check	15-09-21
Drive Pinion Shim Selection	15-09-23
Front and Rear Pinion Bearing Cups	15-09-22
Installation	15-09-22
Oil Seal and Wheel Bearing—Semi-Floating Axle	15-09-11
Rear Antilock Brake System Sensor	15-09-34
SPECIFICATIONS	15-09-41
VEHICLE APPLICATION	15-09-1

VEHICLE APPLICATION

F-250 Light Duty (Semi-Float), F-250 H.D.—F-350 (Full Float) Vehicles.

DESCRIPTION AND OPERATION

Description

The Ford Truck Integral Carrier rear axle assembly is an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of an 10-1/4 inch diameter ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings. Pinion bearing preload is adjusted by the pinion nut and a collapsible spacer maintains the seating of the inner race.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses a silicone sealant as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion shaft is retained with a threaded bolt assembled to the case. The differential case assembly is mounted in the carrier between two opposed tapered roller bearings. The bearings are retained in the carrier by removable bearing caps.

The full-floating rear axle features **brake drums that are mounted outboard of the hub.** Therefore, when brake inspection or replacement is required the hub assembly need not be removed.

The hub is supported or "floats" on the axle spindle on two opposed tapered roller bearings. It is retained on the spindle by a ratcheting nut that is tabbed to a slot on the spindle. **If, for any reason, the hub is removed from the spindle, the old hub seal must be removed and a new hub seal installed.**

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DESCRIPTION AND OPERATION (Continued)

Functional differences between the semi-float integral rear axle assembly and the full-float integral rear axle assembly are as follows:

1. The semi-float axle shafts are retained in the axle by C-washer locks positioned in a slot on the axle shaft splined end. These C-washers also fit into a machined recess in the differential side gears within the differential case.
2. The full-float axle shafts are retained by bolts attached to the hub. The hub rides on two bearings at the outboard end of the axle tube.
3. A semi-float axle shaft rides on one straight-roller bearing at the outboard end.
   - Differential Bearing Preload and Ring Gear Backlash are adjusted by the use of shims located between the differential bearing cup/races and the carrier housing.
   - The use of a Pinion Depth Gauge Tool for drive pinion shim selection in conjunction with a dial indicator for differential case shim selection is required for proper gear set adjustment.

Rear Antilock Brakes

F-250/F-350 vehicles use the Rear Antilock Braking System. The system is designed to automatically reduce brake pressure when brake lock-up is detected during braking or on slippery surfaces. The system features a multi-tooth excitor ring that is pressed on the differential case behind the ring gear. If the excitor ring is removed, it must be discarded and replaced with a new one. The excitor ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space provided between the ring gear and excitor ring for measuring the ring gear backface runout.

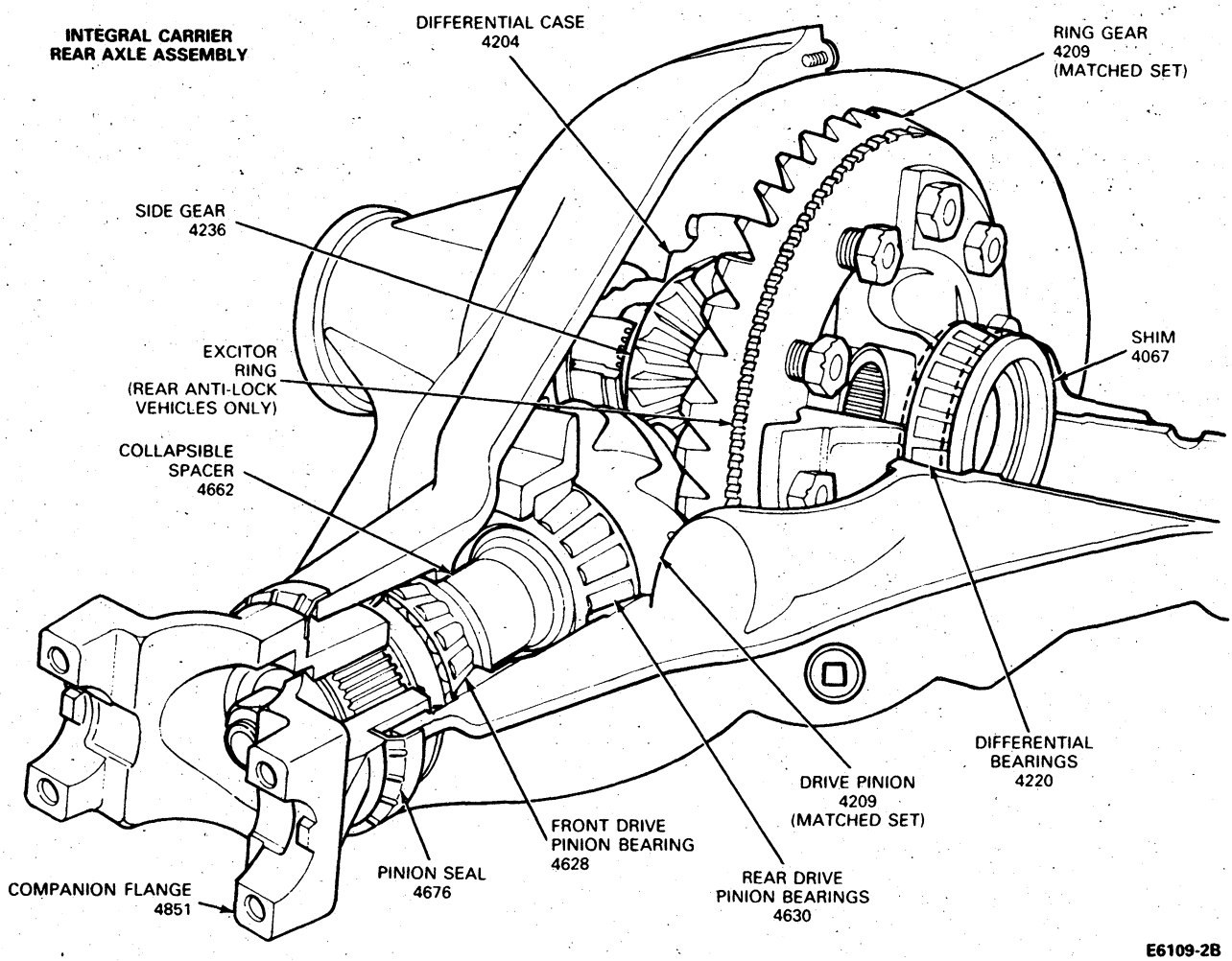
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DESCRIPTION AND OPERATION (Continued)

Operation

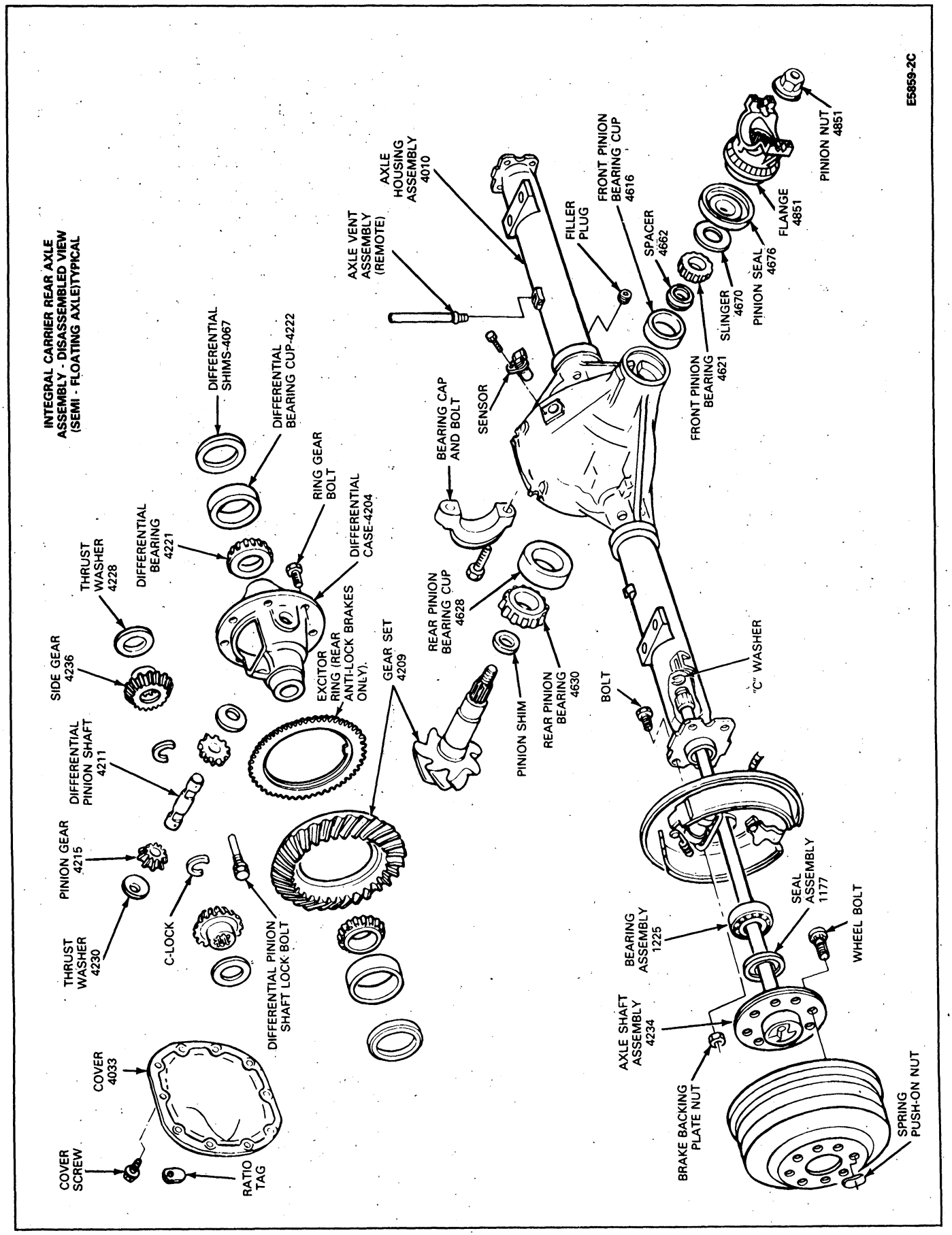
The rear axle drive pinion receives its power from the engine through the transmission and driveshaft. The pinion gear rotates the differential case through engagement with the ring gear, which is bolted to the case outer flange.

Inside the case, two differential pinion gears are mounted on the differential pinion shaft which is pinned (with lock bolt) to the case. These pinion gears are engaged with the side gears, to which the axle shafts are splined. Therefore, as the differential case turns, it rotates the axle shafts and rear wheels. When it is necessary for one wheel and axle shaft to rotate faster than the other, the faster turning side gear causes the pinions to roll on the slower turning side gear to allow differential action between the two axle shafts.

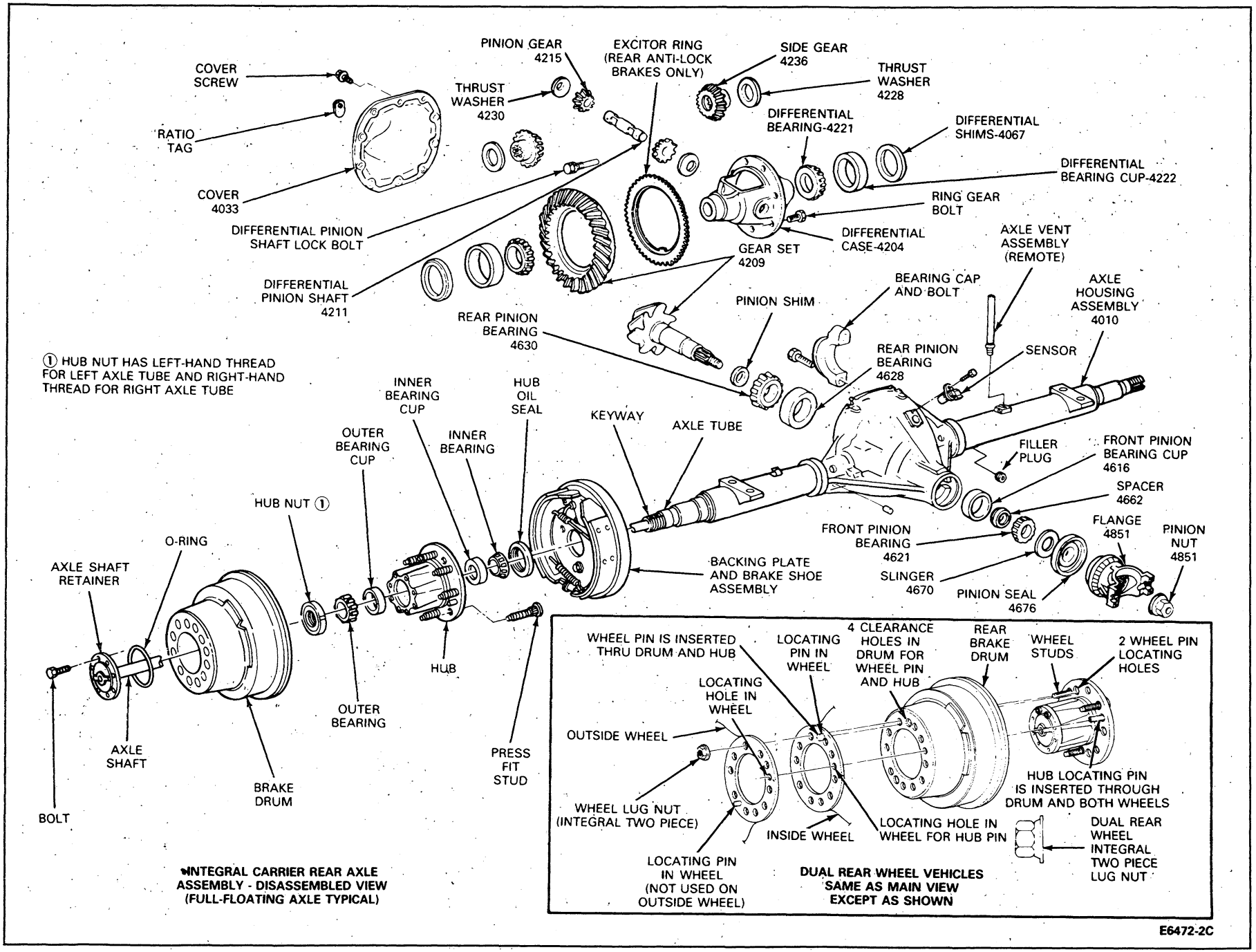


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DESCRIPTION AND OPERATION (Continued)



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INTEGRAL CARRIER REAR AXLE ASSEMBLY - DISASSEMBLED VIEW (FULL-FLOATING AXLE TYPICAL)

DUAL REAR WHEEL VEHICLES SAME AS MAIN VIEW EXCEPT AS SHOWN

E6472-2C

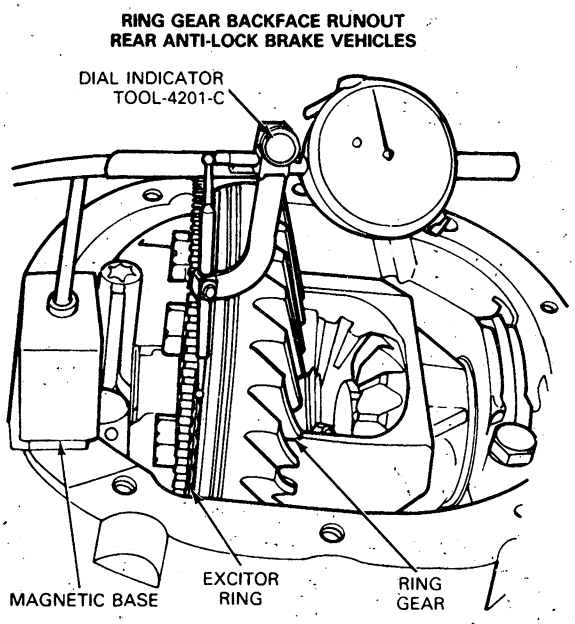
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CLEANING AND INSPECTION

Inspection Before Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the carrier casting. These inspections can find the cause of the concern and determine the resolution.

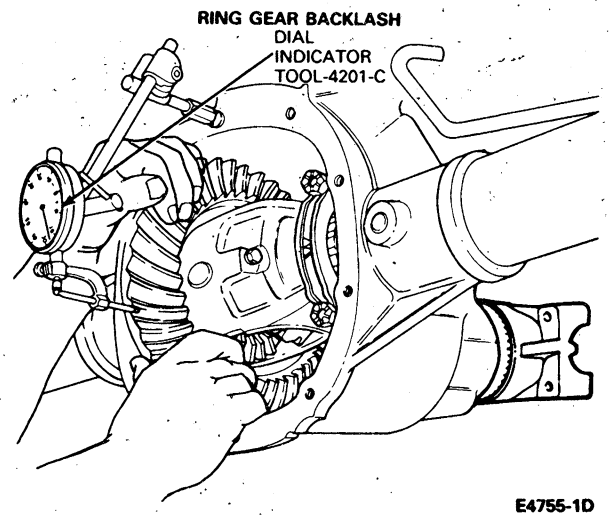
1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.



4. Set up a dial indicator and check ring gear backlash and ring gear backface runout. Backlash should be 0.008 inch to 0.015 inch (0.012-0.015 inch preferred). To check ring gear backface runout, mount Dial Indicator with Bracketry, TOOL-4201-C, or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear. Backface runout should be no more than 0.101mm (0.004 inch).

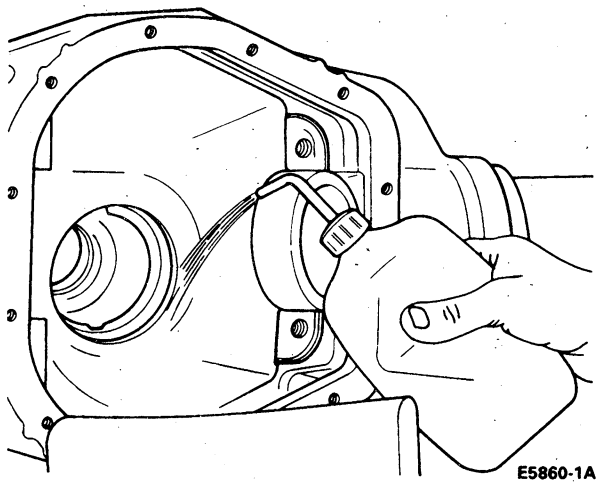
NOTE: There is a space provided between the excitor ring and the ring gear for measuring ring gear backface runout.

5. A contact pattern is not an acceptable guide to check for noise. Proper gear set assembly must be checked using the Rear Axle Pinion Depth Gauge Tool set which shows the correct pinion shim required to assure acceptable running condition. See section on Drive Pinion and Gear Set.



Inspection After Disassembly

Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air. Oil the bearings immediately to prevent rusting. Inspect the parts for any major damage. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.

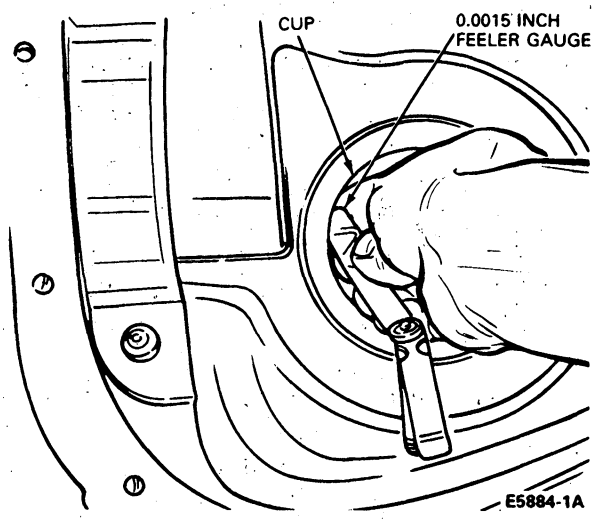


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CLEANING AND INSPECTION (Continued)

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.0381mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be re-seated.



Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Companion Flange

Be sure that the flange half-rounds and lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

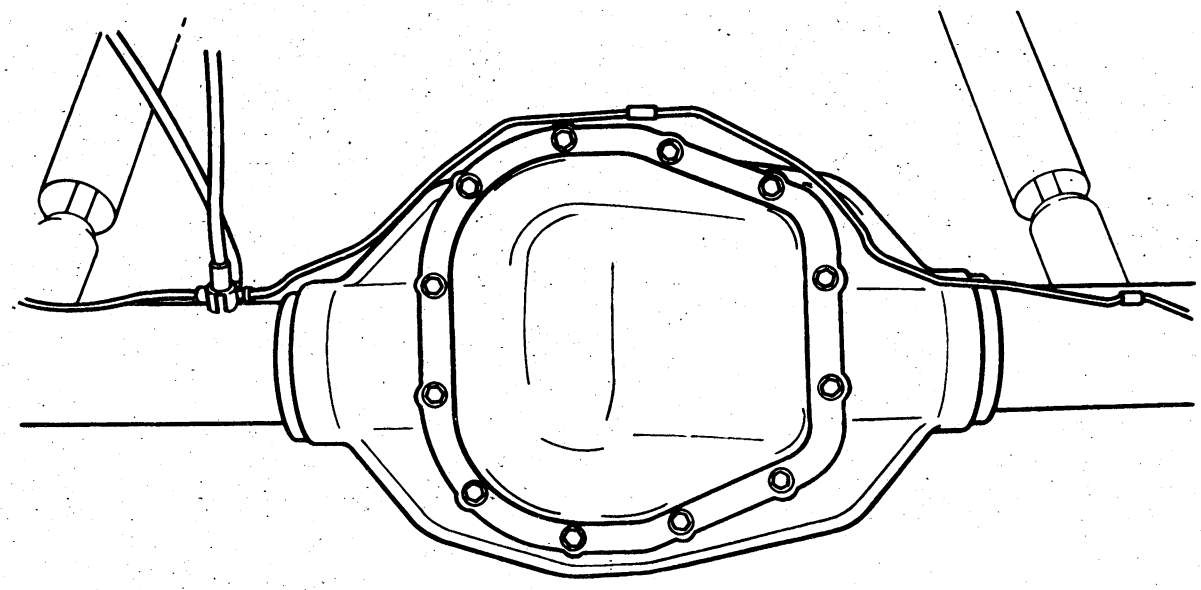
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REMOVAL AND INSTALLATION

Axle Shaft—Semi-Floating Axle

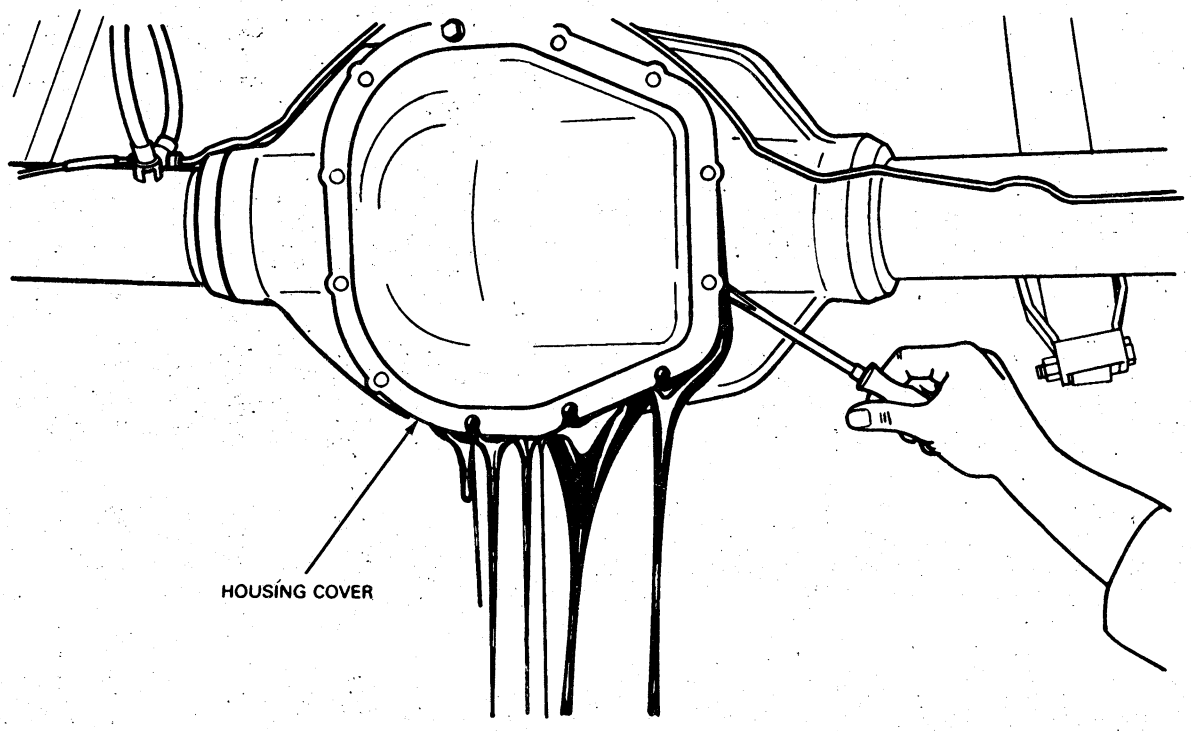
Removal

1. Clean all dirt from the area of carrier cover with a wire brush and/or cloth.



E5863-2A

2. Drain rear axle lubricant by REMOVING THE HOUSING COVER.

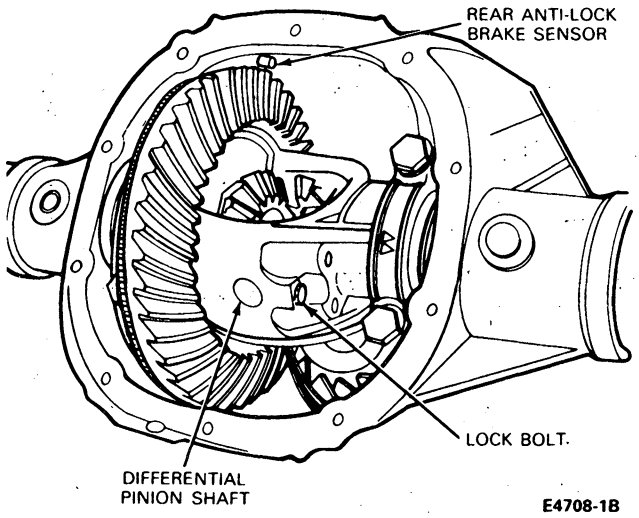


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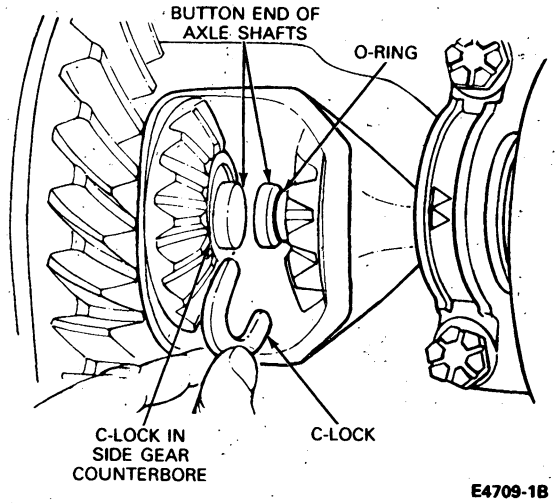
REMOVAL AND INSTALLATION (Continued)

3. Remove differential pinion shaft lock bolt and differential pinion shaft.

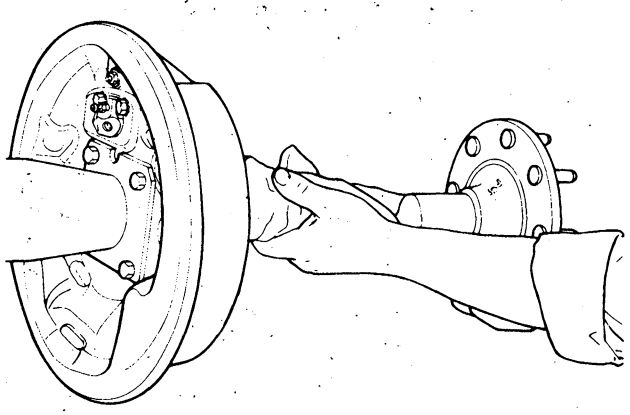


4. Push axle shafts inboard. Remove C-lock from the button end of each axle shaft.

NOTE: Use care not to lose or damage the rubber O-ring which is in the axle shaft groove under the C-lock.



5. Remove the axle shaft from the housing, being careful not to damage the oil seal.

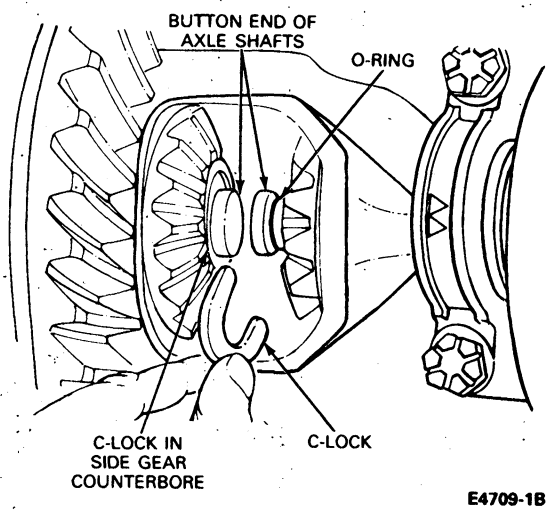


Installation

1. Slide the axle shafts into place in the axle housing. Exercise care so that the splines or any portion of the axle shafts do not damage the oil seals. Push the shafts inboard (toward the center of the vehicle) enough to allow installation of the C-lock.

   Install the axle shaft C-locks on the button end of the axle shafts and push the shafts outboard so that the shaft lock seats in the counterbore of the differential side gear.

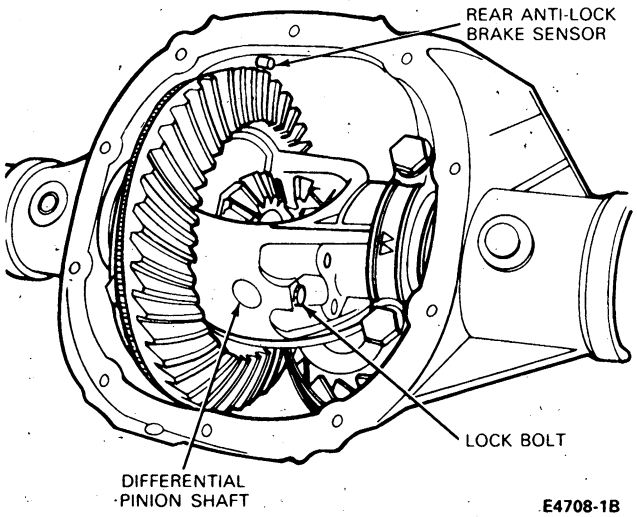
NOTE: A rubber O-ring is used to hold the C-lock in position on the axle shaft. Be sure that the O-ring is in the groove at the button end of the axle shaft before installing the C-lock.



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REMOVAL AND INSTALLATION (Continued)

2. Position the differential pinion shaft through the case and pinions, aligning the hole in the shaft with the lock bolt hole. Apply Loctite (E0AZ-19554-B or equivalent) to the lock bolt threads. Install lock bolt and tighten to 20-40 N·m (15-30 ft-lbs).

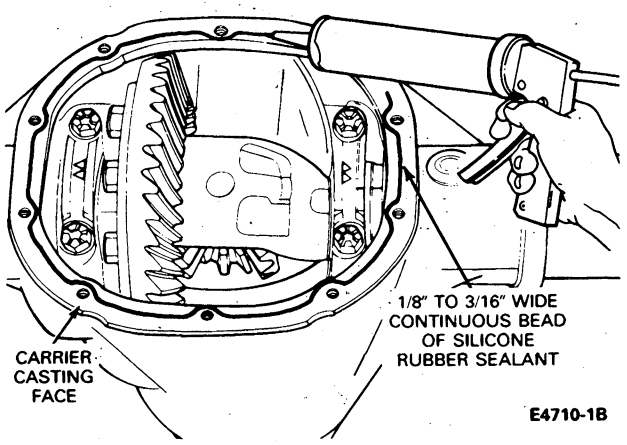


E4708-1B

3. Clean the gasket mating surface of the rear axle carrier casting and cover.

   Apply a new continuous bead of silicone rubber sealant (D6AZ-19562-AA or -BA or equivalent) to the carrier casting face inside the cover bolt holes.

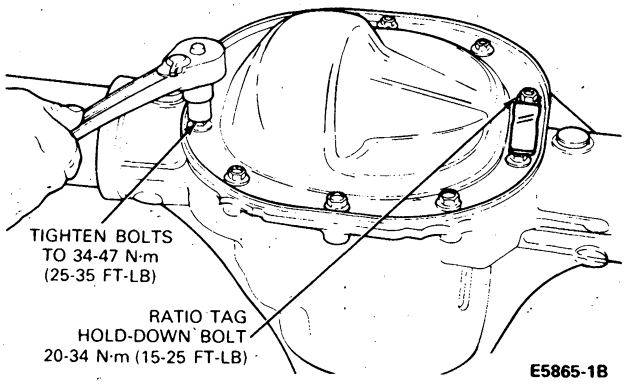
CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.



E4710-1B

4. Install cover and tighten cover bolts to 34-47 N·m (25-35 ft-lbs) as shown. Tighten the cover bolts in a cross-wise pattern to insure uniform draw on cover. Tighten the ratio tag hold-down bolt to 20-34 N·m (15-25 ft-lbs).

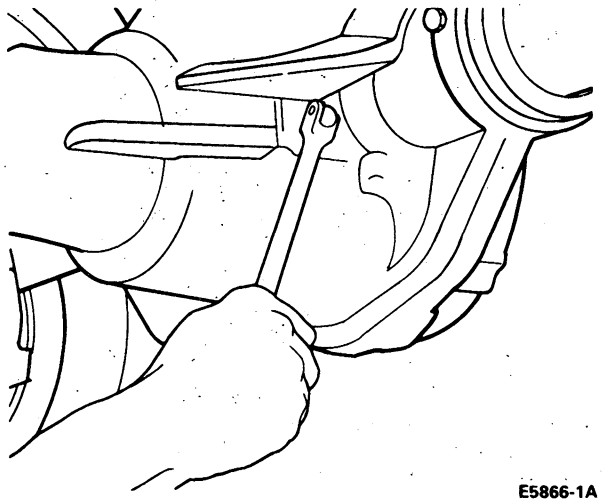
NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.



E5865-1B

5. For in-vehicle repairs, add lubricant through the filler hole until the lubricant level reaches the bottom of the filler hole with the axle in the running position (approximately 6.5 U.S. pints). For out-of-vehicle repairs, add 7.5 U.S. pints of lubricant. Use Hypoid Gear Lubricant E0AZ-19580-A (ESP-M2C154-A) or equivalent for conventional axles, plus 8 ounces of C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for complete refill of Limited-Slip Applications.

   Lower vehicle and road test.


E5866-1A

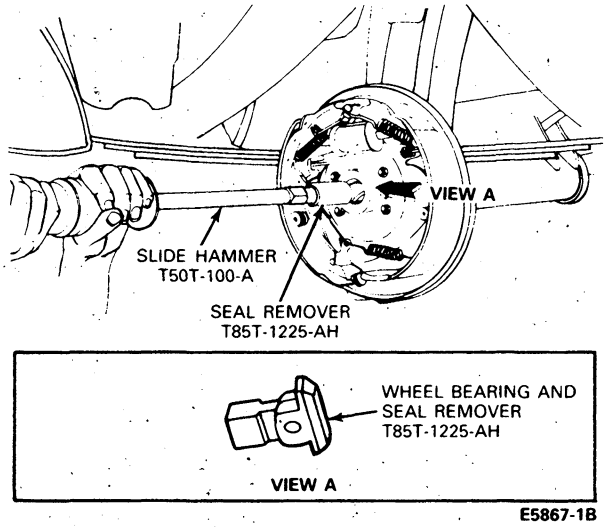
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REMOVAL AND INSTALLATION (Continued)

Oil Seal and Wheel Bearing—Semi-Floating Axle

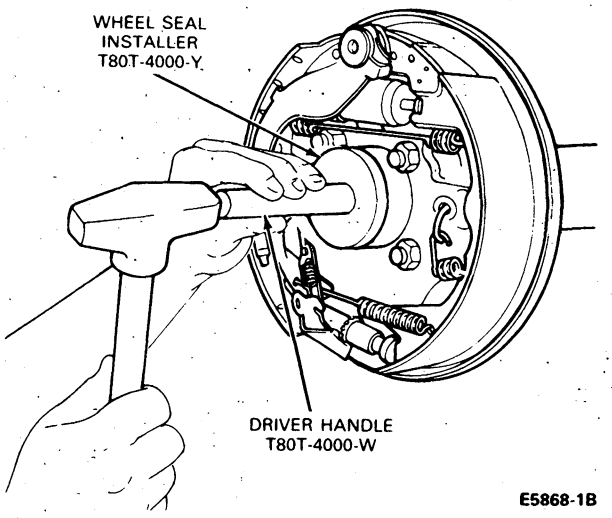
Removal

1. Using Slide Hammer, T50T-100-A and Seal Remover, T85T-1225-AH or equivalents, insert into the bore as shown and position it behind the bearing so the tangs on the tool engage the bearing outer race. Remove the bearing and seal as a unit, using the slide hammer.



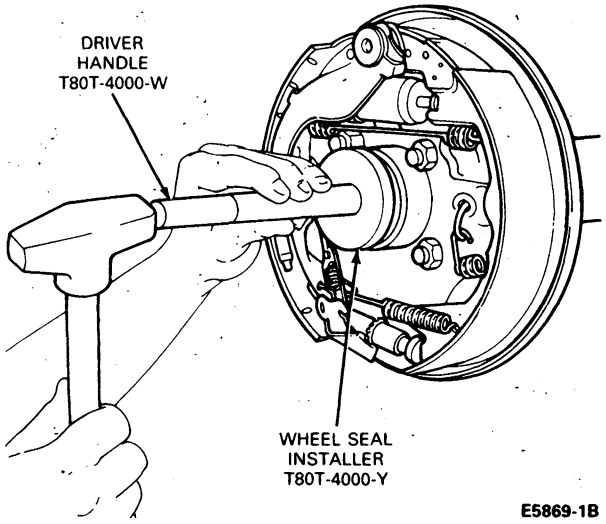
Installation

1. Lubricate the new bearing with rear axle lubricant and install the bearing into the housing bore using Driver Handle, T80T-4000-W and Wheel Seal Installer, T80T-4000-Y.



2. Coat the lips of the seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent and install the axle shaft seal.

CAUTION: Installation of the bearing or seal assembly without the proper tool may result in an early bearing or seal failure. If seal becomes cocked in the bore during installation, remove it and install a new one.

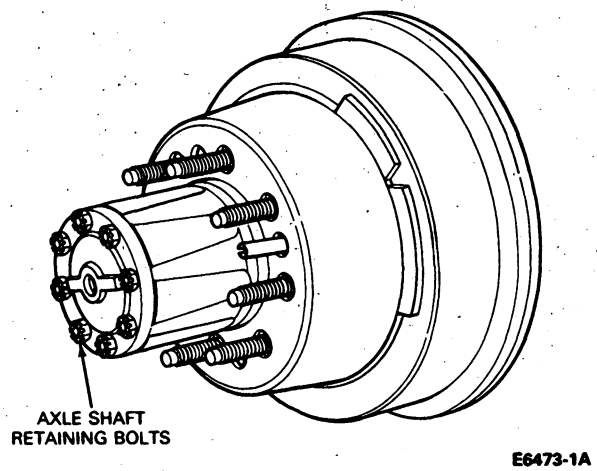


Axle Shaft, Hub, Oil Seal and Outer Wheel Bearing

Full Floating Axle

Removal

1. Set the parking brake and **loosen** the eight axle shaft retaining bolts.
2. Raise the vehicle to the desired working height, keeping the axle parallel with the floor.
3. Release parking brake and back off the rear brake adjustment, if necessary.
4. Remove the wheel and tire assembly.

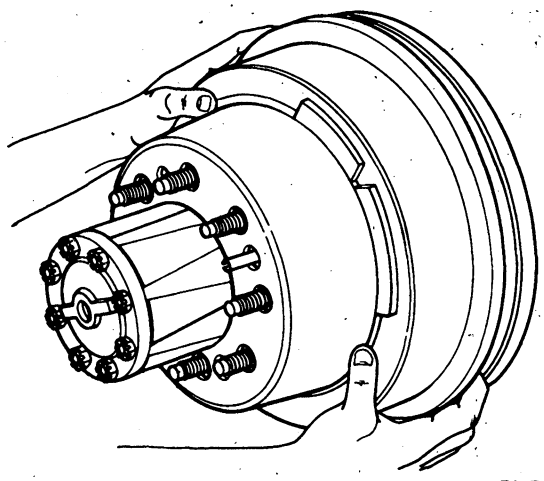


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REMOVAL AND INSTALLATION (Continued)

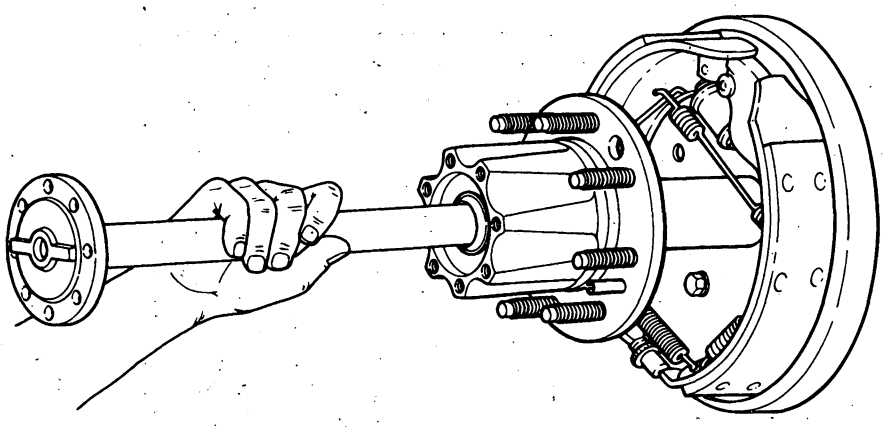
5. Remove brake drum. If equipped, push-on (sheet metal) drum retainer nuts may be discarded.

NOTE: Push-on retainer nuts are used for shipping purposes only and have no effect on vehicle function.



E6474-1A

6. Remove the eight 7/16-inch axle shaft bolts and remove the axle shaft.



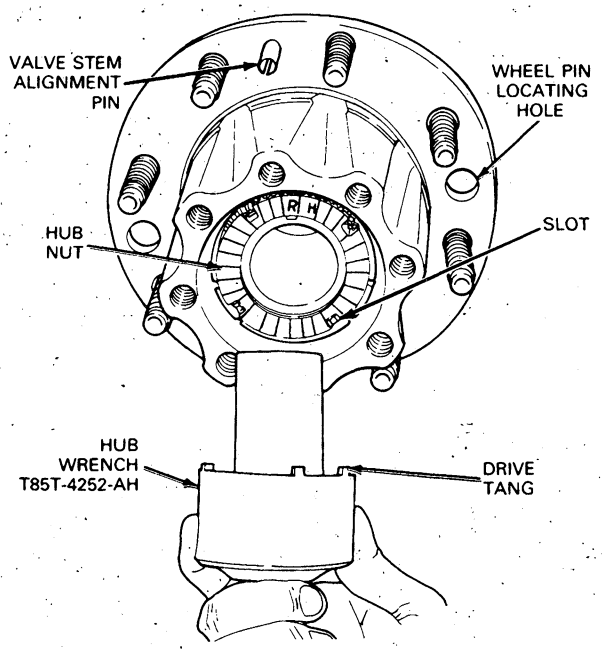
E6475-2A

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REMOVAL AND INSTALLATION (Continued)

7. Install Hub Wrench T85T-4252-AH so that the drive tangs of the tool engage the four slots in the hub nut.

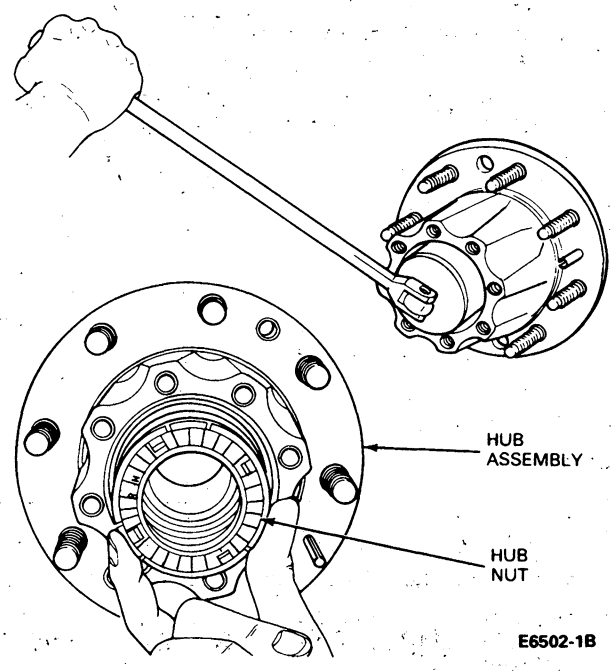
CAUTION: The hub nuts are right hand thread (right hub) and left hand thread (left hub). Each hub nut is stamped RH for right hub nuts or LH for left hub nuts.



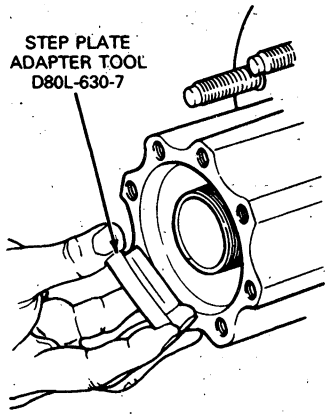
8. Remove hub nut (counterclockwise for right hand thread; clockwise for left hand thread).

CAUTION: Under no circumstances are power impact tools to be used when performing these operations.

NOTE: The hub nut will ratchet during this operation.



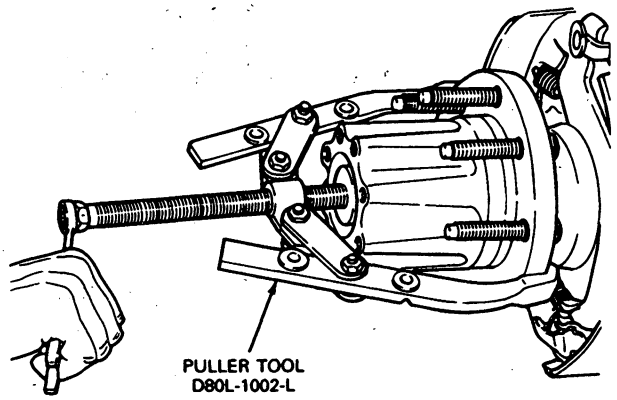
9. Install Step Plate Adapter Tool D80L-630-7.



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REMOVAL AND INSTALLATION (Continued)

10. Install Puller Tool D80L-1002-L or equivalent and loosen hub to the point of removal. Remove puller tool and step plate.



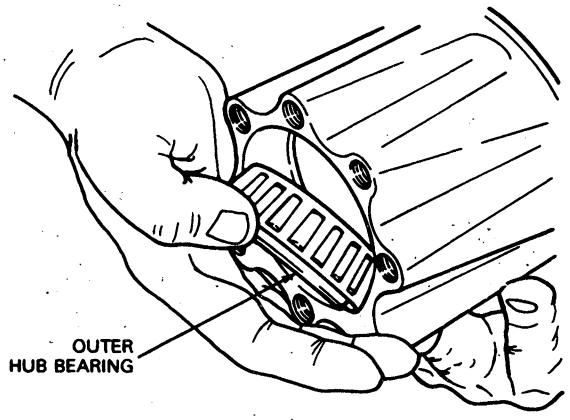
E6504-1A

11. Remove hub assembly.

CAUTION: Do not drop outer hub bearing.

12. To replace hub oil seal, refer to HUB DISASSEMBLY AND ASSEMBLY in this Section.

NOTE: The inner bearing is located behind the hub oil seal.



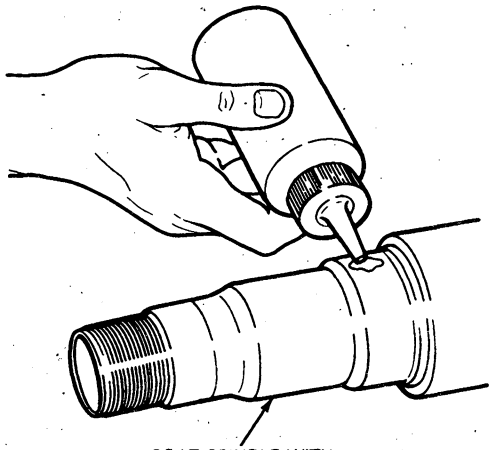
E6505-1A

Installation

1. Clean spindle thoroughly after hub removal, then coat the spindle with axle lubricant.

NOTE: Hub bearings must be prelubed with grease prior to installation. Use Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

2. Pack each bearing cone and roller assembly with a bearing packing tool, using lithium base Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.



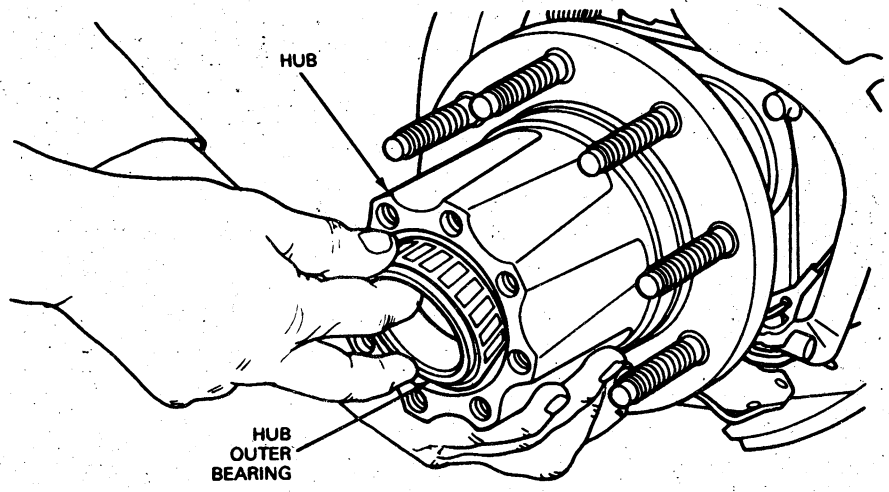
E6506-1A

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REMOVAL AND INSTALLATION (Continued)

3. Push hub **and hub outer bearing** onto spindle.

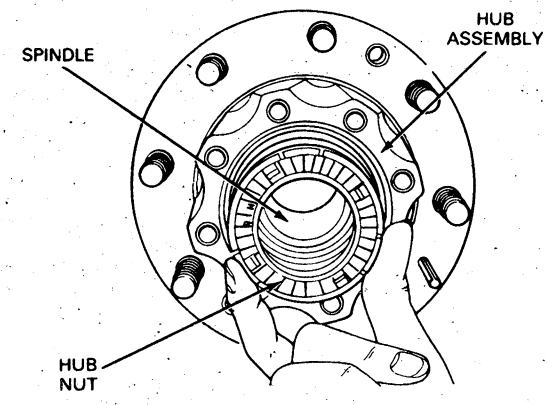
NOTE: Installing the hub in this manner causes the hub outer bearing to act as a pilot making the installation easier.

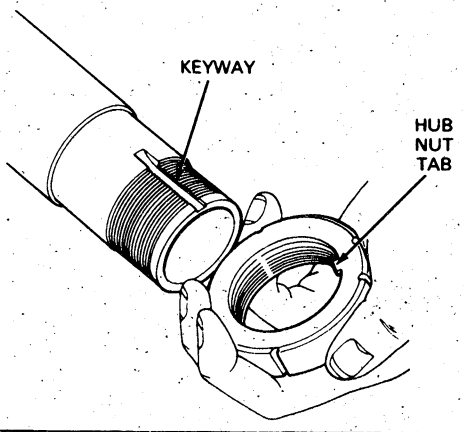


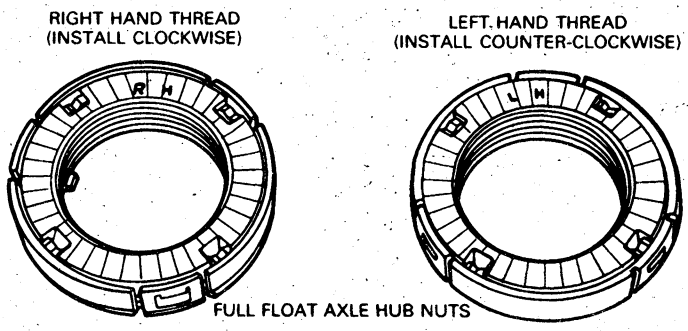
E6507-2A

4. Install the hub nut on the spindle. Turn hub nut clockwise for right hand (RH) thread, counterclockwise for left hand (LH) thread.

CAUTION: Make sure the hub nut tab is located in the keyway prior to thread engagement.







E6508-2C

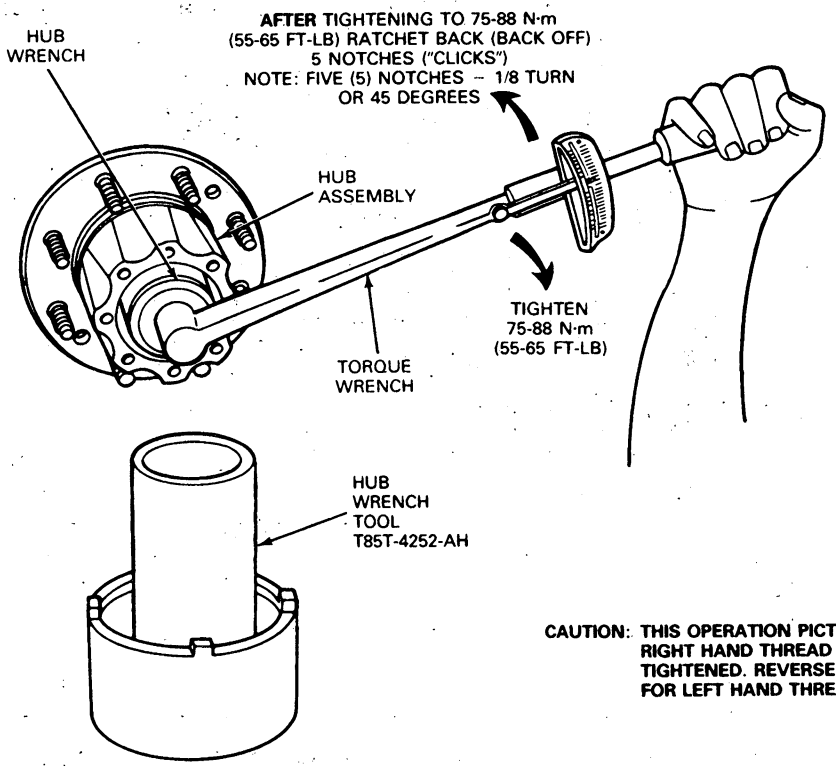
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REMOVAL AND INSTALLATION (Continued)

5. Install Hub Wrench Tool T85T-4252-AH on spindle.
6. Install torque wrench and tighten hub nut to 75-88 N·m (55-65 ft-lbs). Rotate hub occasionally while tightening.

NOTE: The hub nut will ratchet as torque is applied.

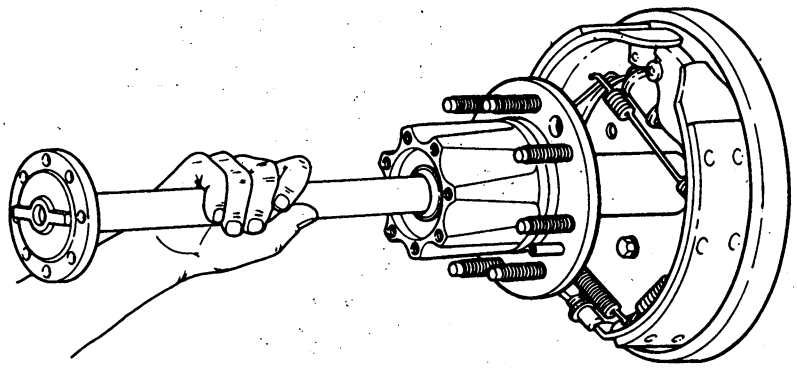
7. After tightening to specification (75-88 N·m [55-65 ft-lbs]), ratchet back five (5) teeth or notches on the hub nut. **Five (5) "clicks" must be heard** during this operation in order to have performed it correctly.

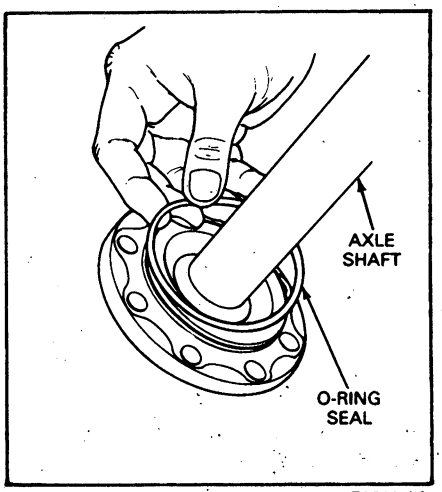


CAUTION: THIS OPERATION PICTURES A RIGHT HAND THREAD NUT BEING TIGHTENED. REVERSE THIS PROCEDURE FOR LEFT HAND THREAD NUT.

E6509-2C

8. Inspect axle shaft O-ring seal for cracks, nicks or wear and replace if required.
9. Install the axle shaft.
10. Coat the threads of all eight (8) axle shaft retaining bolts with Loctite or equivalent.
11. Install and tighten axle shaft retaining bolts until they seat.





E6510-2A

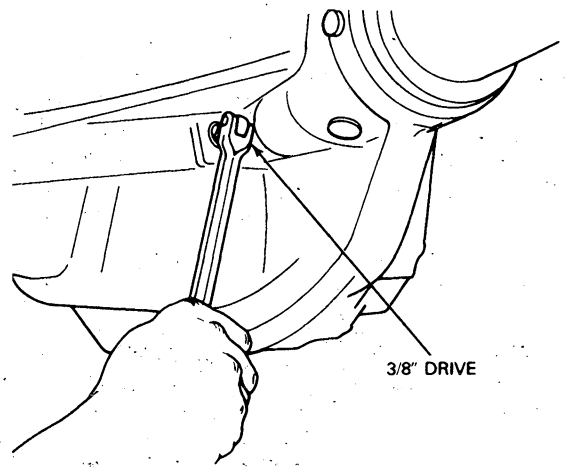
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REMOVAL AND INSTALLATION (Continued)

NOTE: Prior to installing drum, adjust brake so that brake diameter is 0.762mm (0.030 inch) less than drum diameter.

CAUTION: Remember, the last step of this procedure is to tighten the axle shaft bolts to specification, after the wheel lug nuts have been tightened.

12. Install brake drum.
13. Install wheel and tire assembly.
14. Loosen filler plug. If axle lube begins to seep out, retighten filler plug. If there is no lubricant seepage, remove filler plug and fill to bottom of filler plug hole with specified lubricant.
15. Install filler plug and tighten to 21-40 N·m (15-30 ft-lbs).
16. Lower the vehicle.
17. Make brake adjustments if necessary.
18. Tighten wheel lug nuts, Single Rear Wheel (SRW) and/or Dual Rear Wheels (DRW) to 190 N·m (140 ft-lbs).
19. Tighten (8) axle shaft retaining bolts to 82-108 N·m (60-80 ft-lbs).



E6511-1B

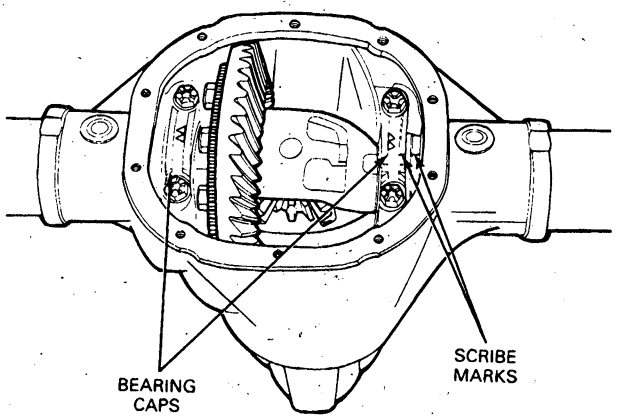
Differential Case and Drive Pinion

Removal

1. If not removed, remove the axle shafts as described in this Section.
2. Mark one differential bearing cap to ensure the caps are installed in their original positions during assembly.

CAUTION: Right and left bearing caps must not be interchanged.

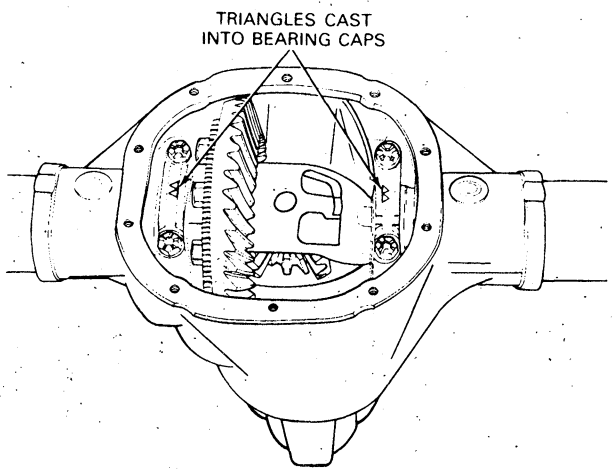
NOTE: Before removing the differential case, check the ring gear runout as described under Inspection Before Disassembly in the Cleaning and Inspection portion of this Section. If ring gear runout exceeds 0.101mm (0.004 inch), the differential case and ring gear must be removed to perform the Differential Runout Check. The Differential Runout Check will isolate the cause of excessive Ring Gear Runout.



E4707-1C

3. Loosen the differential bearing cap bolts and bearing caps.

NOTE: The direction of triangles on bearing caps must be noted. When re-assembled the triangles must be pointing in the same direction (out-board) as before removal.



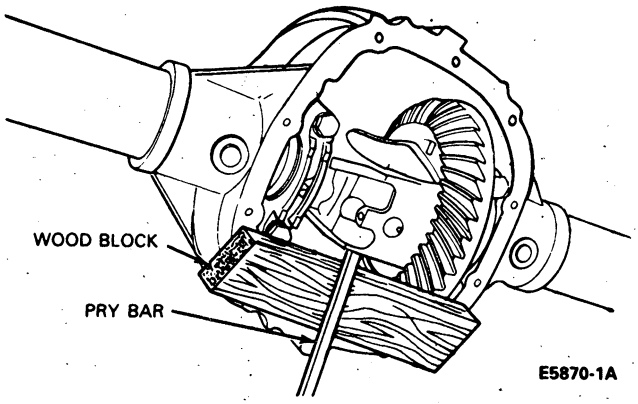
E4763-1B

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REMOVAL AND INSTALLATION (Continued)

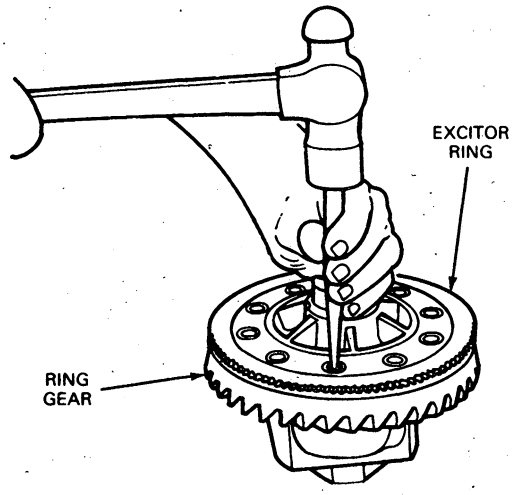
4. Pry the differential case, bearing cups and shims out until they are loose in the bearing caps. Remove the bearing caps and remove the differential assembly from the carrier.

CAUTION: When using the pry bar, place a wood block between the pry bar and the axle housing to protect the machined surface from damage.

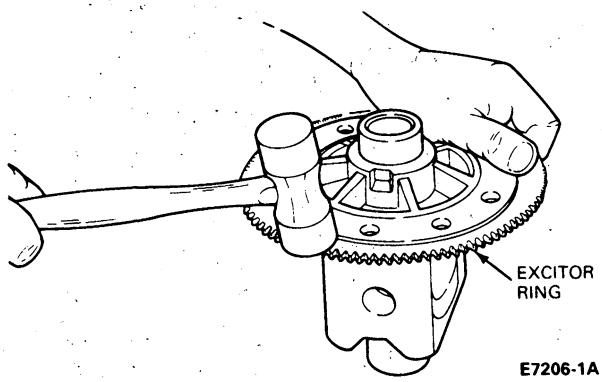


5. If required, remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case by striking at alternate holes around the gear.

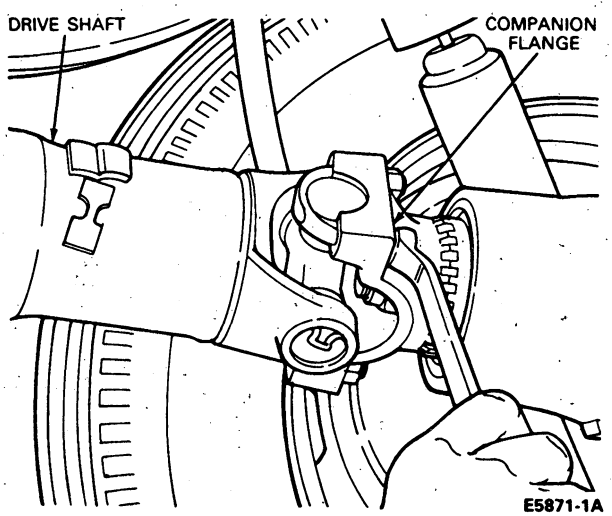
CAUTION: Do not damage excitor ring when removing ring gear. If excitor ring is removed, it must be replaced with a new one.



6. If required remove the excitor ring with a soft faced hammer. Discard the excitor ring.



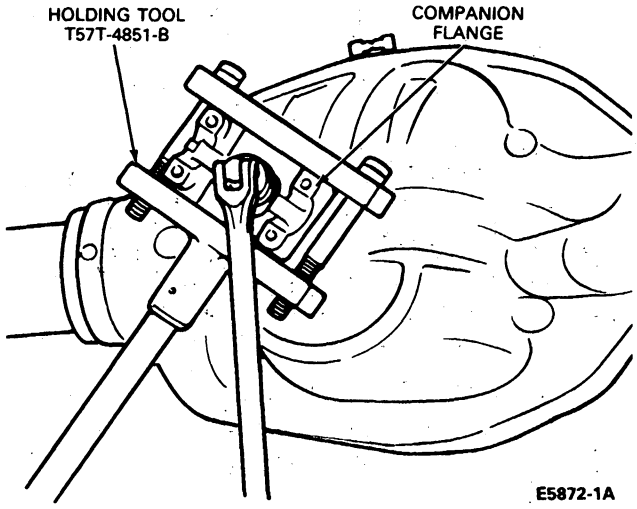
7. Mark the driveshaft in relation to the companion flange. Remove the drive shaft-to-axle-companion flange U-bolts and nuts. Remove the driveshaft assembly.



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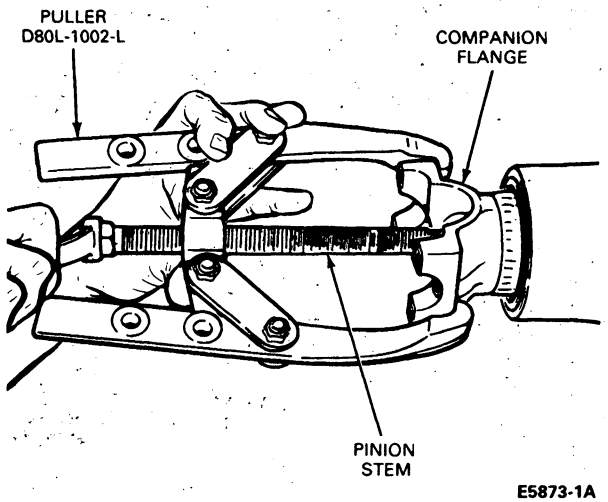
REMOVAL AND INSTALLATION (Continued)

8. Install Holding Tool, T57T-4851-B on the companion flange and remove the pinion nut.



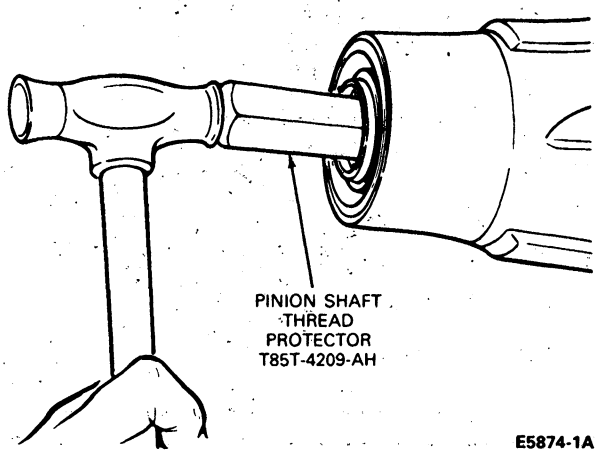
9. Remove the companion flange using Puller, D80L-1002-L or equivalent. Care should be taken not to allow the drive pinion to fall from the housing.

NOTE: Scribe a mark on the companion flange and pinion stem and align the marks when reassembling.



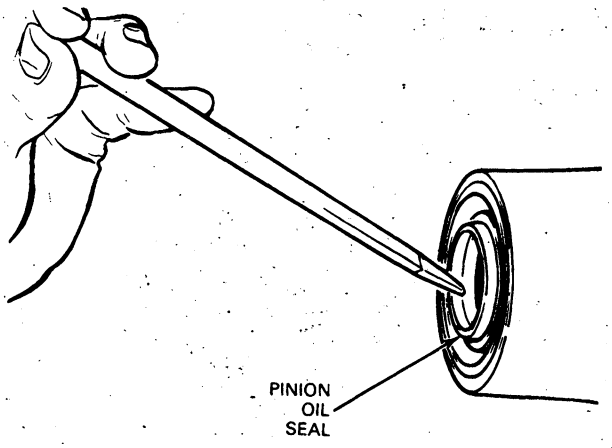
10. With a soft-faced hammer, drive the pinion out of the front bearing cone and remove it through the rear of the housing.

If available, install Pinion Shaft Thread Protector, T85T-4209-AH on the pinion threads and drive the pinion from the housing.



11. Remove the drive pinion oil seal.

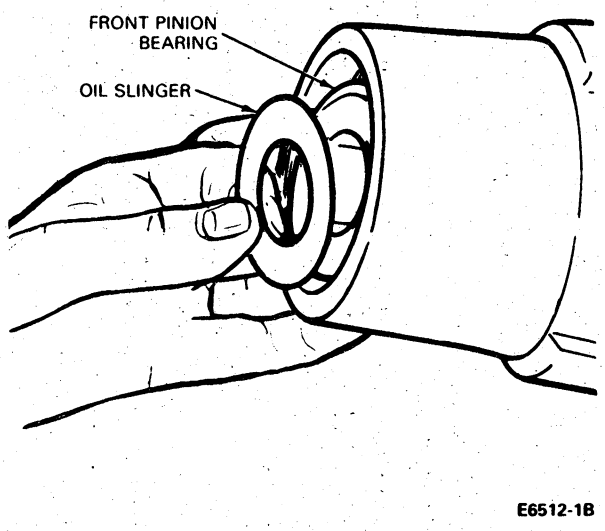
CAUTION: Use care not to damage seal bore in housing.



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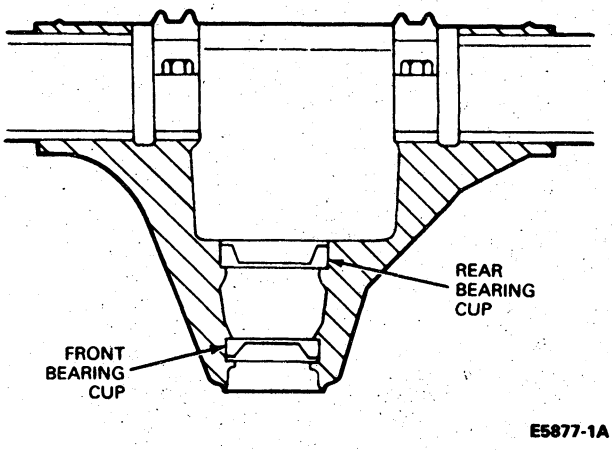
REMOVAL AND INSTALLATION (Continued)

12. Remove oil slinger and front pinion bearing from axle housing.

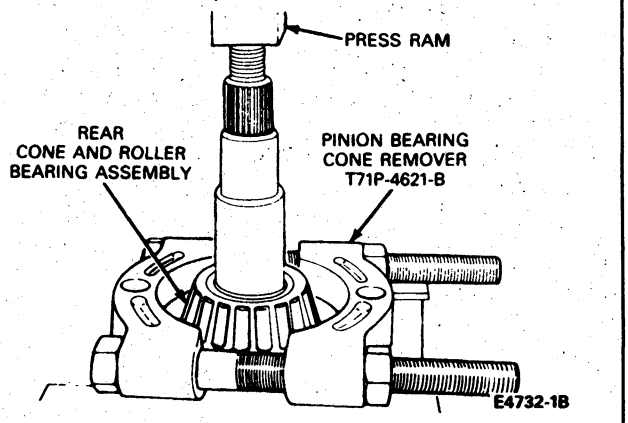


13. NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

    If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on the opposite side of the cups during removal to prevent cups from cocking in the casting.



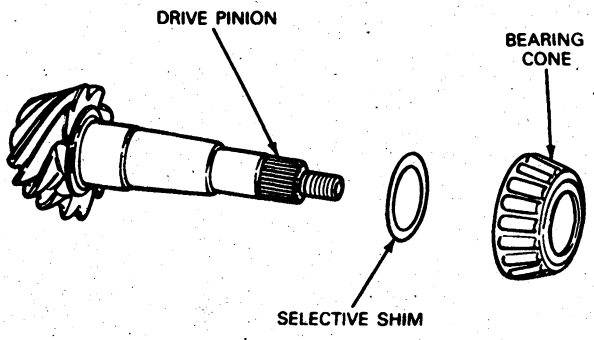
14. To remove the pinion rear cone and roller bearing assembly, use the Pinion Bearing Cone Remover, T71P-4621-B or equivalent as shown.



15. Remove the selective shim from the drive pinion.

NOTE: Measure the shim, which is found under the bearing cone, with a micrometer and record the thickness (as a reference to be compared to the shim gauge reading prior to installing the bearing).

16. For differential case disassembly procedures, refer to Differential Case—Disassembly and Assembly in this Section.



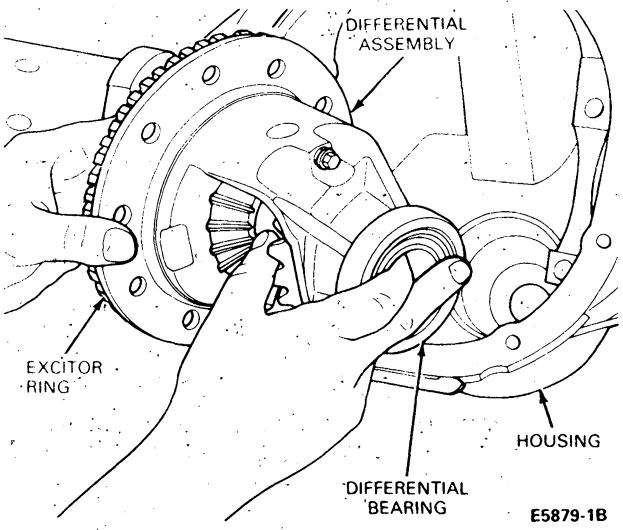
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REMOVAL AND INSTALLATION (Continued)

Differential Runout Check

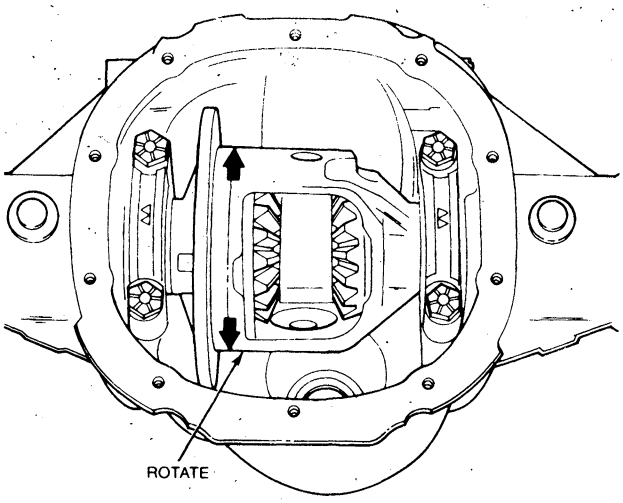
If the ring gear runout check (before disassembly) exceeds specification, the condition may be caused by a warped ring gear, a damaged case, excessively worn differential bearings or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout, proceed as follows:

1. Remove the differential case from the axle housing (refer to Differential case and Drive Pinion Removal in this Section) and remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case with a hammer and a drift.
2. Install the differential assembly including the bearing cups and shims in the axle housing. Tighten the bearing cap bolts to 109-128 N·m (80-95 ft-lbs).



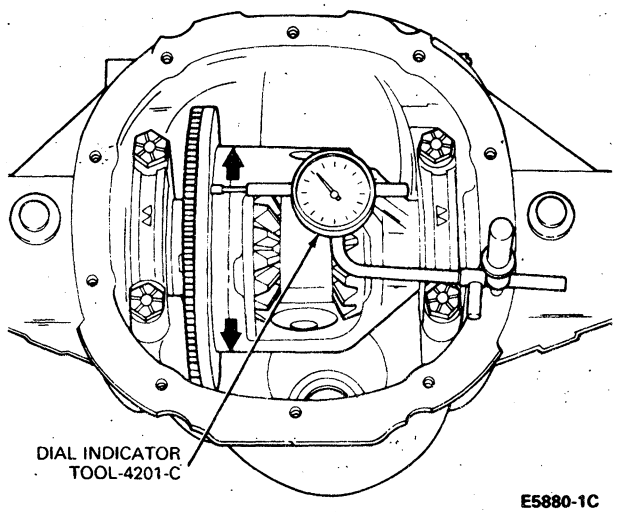
E5879-1B

3. Rotate assembly to insure proper seating of differential bearings.



E4740-1A

4. Check the runout of the differential case flange with a dial indicator TOOL-4201-C or equivalent. If the runout is within specification, (Max. 0.003 inch), install a new ring and pinion gear. If the runout exceeds specification, the ring gear is true and the trouble is due to either a damaged case or bearings. Visually inspect the bearings. If bearings are not damaged, replace both the case and bearings. Recheck the runout with new parts (case and bearings).

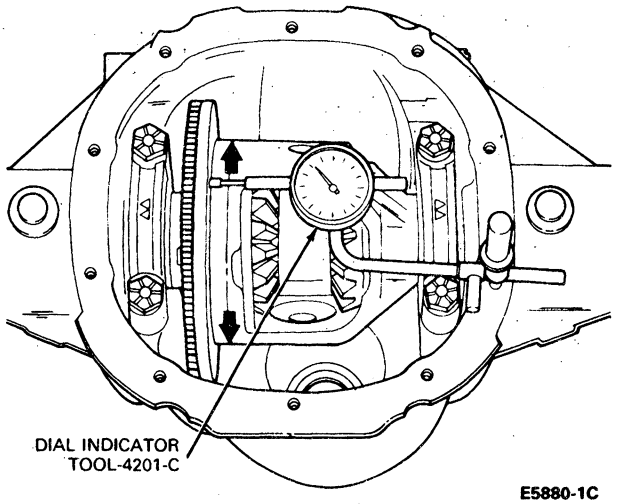


E5880-1C

5. Install new differential bearings on the case hubs using Replacer Tool, D81T-4221-A or equivalent and install the differential assembly in the carrier without the ring gear.

NOTE: Press against the bearing cone only.

6. Check the case runout again with the new bearings. If the runout is now within limits, use the new bearings for assembly. If the runout is still excessive, the case is damaged and should be replaced.



E5880-1C

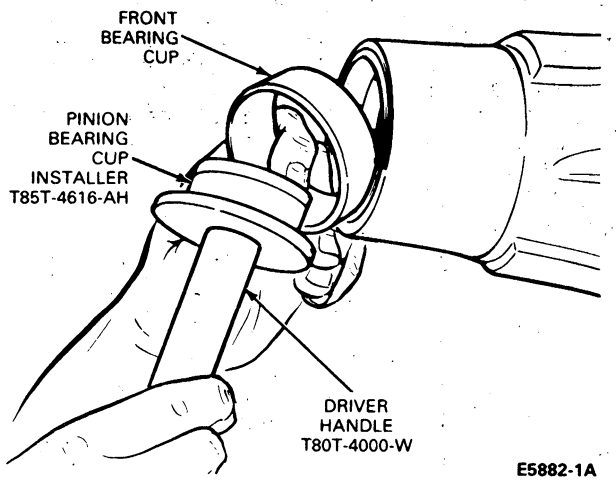
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REMOVAL AND INSTALLATION (Continued)

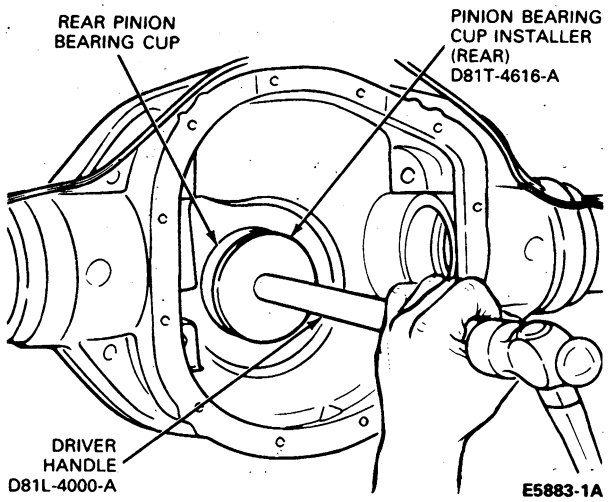
Front and Rear Pinion Bearing Cups

Installation

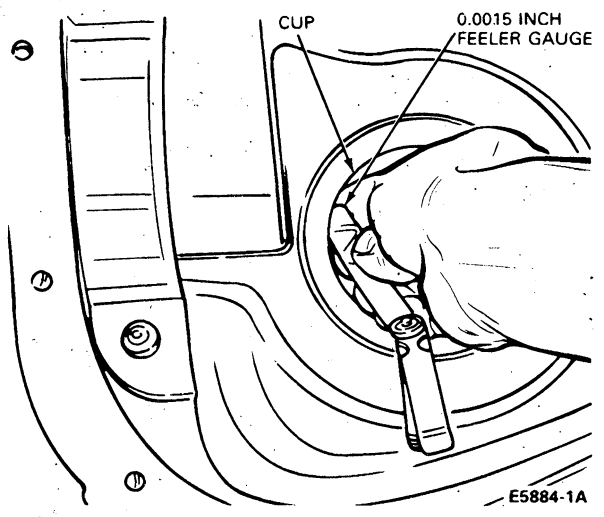
1. Drive the front pinion bearing cup into the housing using Pinion Bearing Cup Installer (Front), T85T-4616-AH and Driver Handle, T80T-4000-W.



2. Drive the rear pinion bearing cup into the housing using Pinion Bearing Cup Installer (Rear), D81T-4616-A and Driver Handle, D81L-4000-A.



3. Make sure the cups are properly seated in their bores. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup is not properly seated. Whenever the cups are replaced, the cone and roller assembly should also be replaced.



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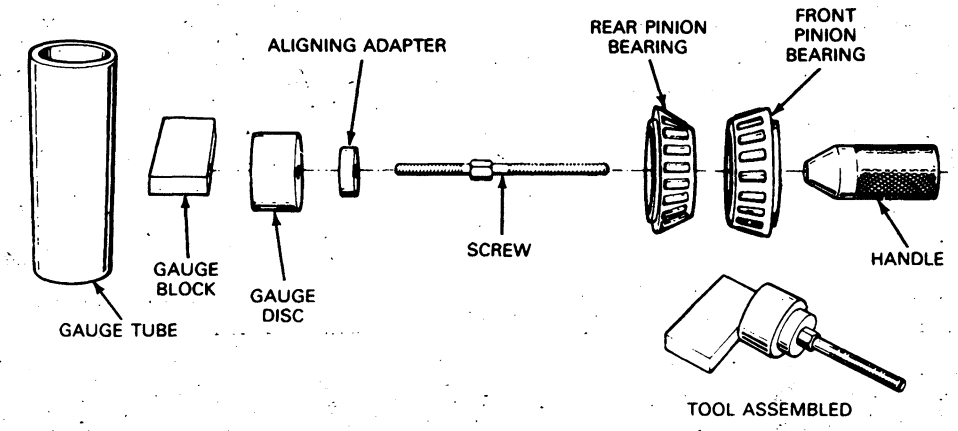
REMOVAL AND INSTALLATION (Continued)

Drive Pinion Shim Selection

1. Individual differences in machining the carrier casting and the gear set and variation in bearing widths require a shim between the pinion rear bearing and pinion head, in order to locate the pinion for correct tooth contact with the ring gear.

   When replacing a ring and pinion gear, the correct shim thickness for the new gear set to be installed is determined by the following procedure using the tools listed below.

2. Assemble the appropriate aligning adapter, gauge disc and gauge block to the screw.



REAR AXLE PINION DEPTH GAUGE TOOL

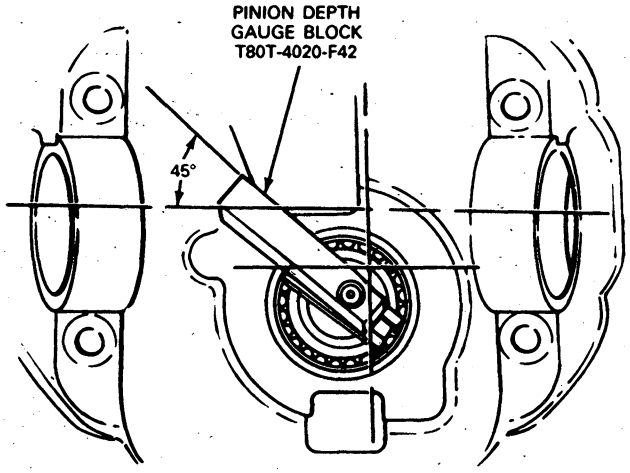
Tool Number*	Description
T85T-4020-AH1	Aligning Adapter
T80T-4020-F43	Screw
T80T-4020-F42	Gauge Block
T76P-4020-A11	Handle
T85T-4020-AH2	Gauge Disc
D81T-4020-F51	Gauge Tube

*The Tool numbers shown in column are part of Tool kit T79P-4020-A.

E5885-2A

3. Place the rear pinion bearing (new, or used if in good condition) over the aligning tool and insert it into the rear pinion bearing cup of the carrier. Place the front bearing into the front bearing cup and assemble the tool handle into the screw. Roll the assembly back and forth a few times to seat the bearings while tightening the tool handle by hand. Tighten the tool handle to 27 N·m (20 ft-lbs).

NOTE: The gauge block must be off-set (45°) to obtain an accurate reading.



E5886-1A

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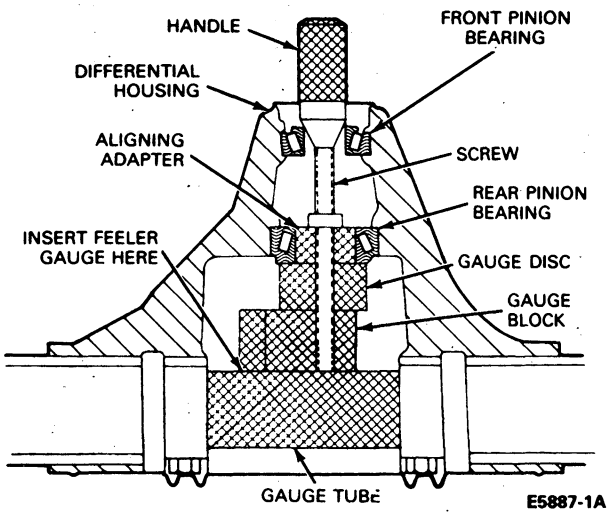
REMOVAL AND INSTALLATION (Continued)

4. Center the gauge tube into the differential bearing bore. Install the bearing caps and tighten the bolts to 95-115 N·m (70-85 ft-lbs). (Caps are to be installed with the triangles pointing outboard.)

Utilize Pinion Shims as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness.

NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.

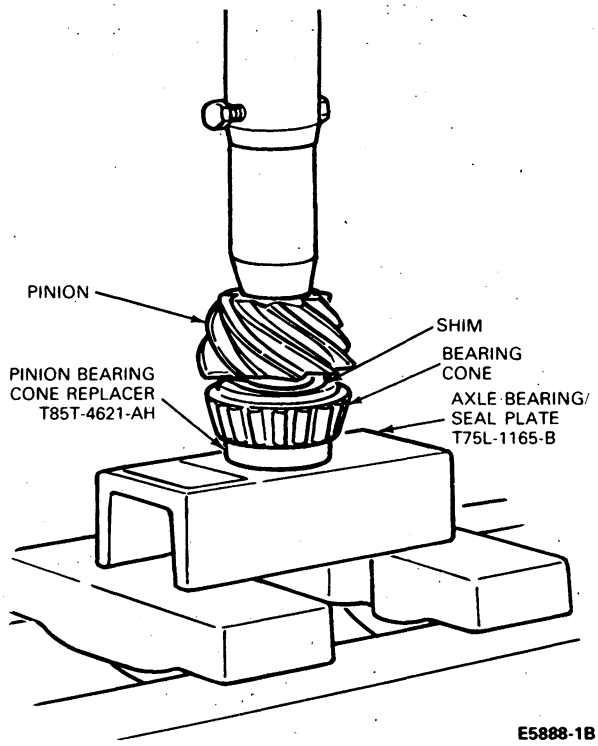
It is important to feel a slight drag on the shim for correct selection. Do not attempt to force the shim between the gauge block and the gauge tube. This will minimize selection of a shim thicker than required which results in a deep tooth contact in final assembly of integral axles.



5. Place the selected shim(s) on the pinion and press the pinion bearing cone and roller assembly until it is firmly seated on the shaft using Pinion Bearing Cone Replacer, T85T-4621-AH and Axle Bearing/Seal Plate, T75L-1165-B.

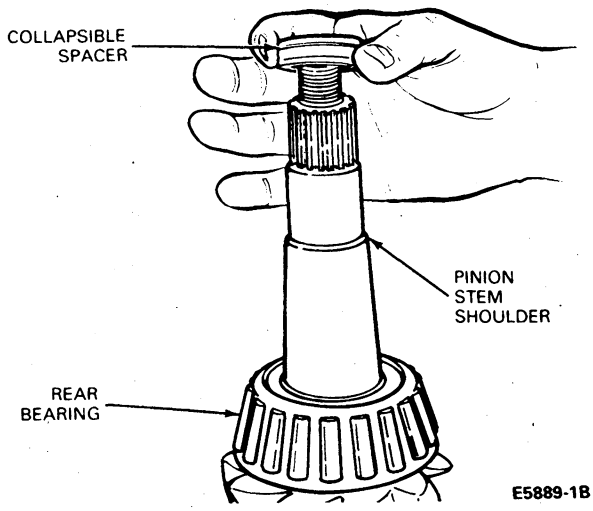
NOTE: The same rear pinion bearing used in this procedure must be used in final assembly of the axle.

NOTE: Be sure that press load is not applied to the bearing cage.



6. Check splines on the pinion stem to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion. Wipe the pinion clean.

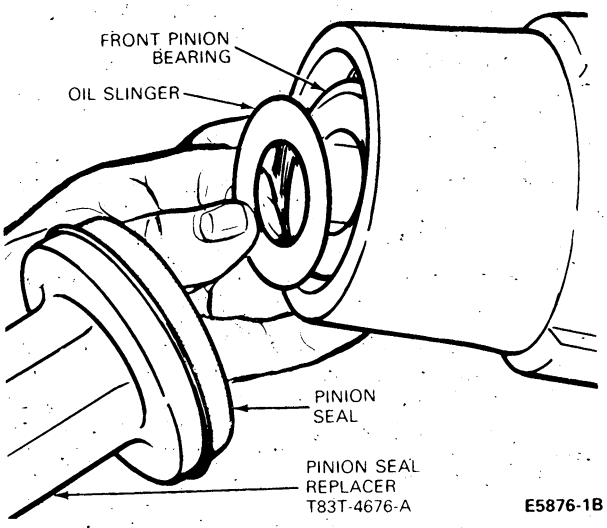
7. Place the collapsible spacer on the pinion stem against the pinion stem shoulder.



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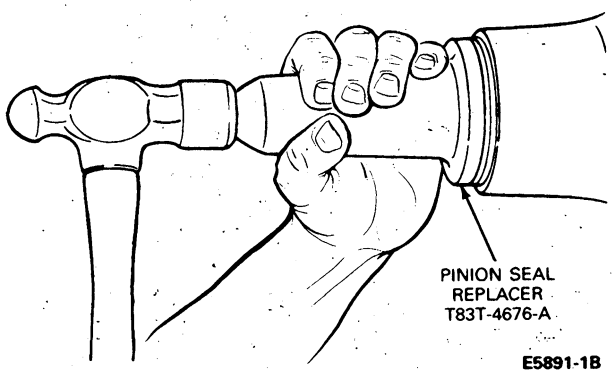
REMOVAL AND INSTALLATION (Continued)

8. Install the front pinion bearing and oil slinger in the housing bore and install the pinion seal on the Pinion Seal Replacer, T83T-4676-A.



9. Clean the oil seal seat surface. Install the seal in the housing bore using Pinion Seal Replacer, T83T-4676-A. Coat the lips of the seal with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

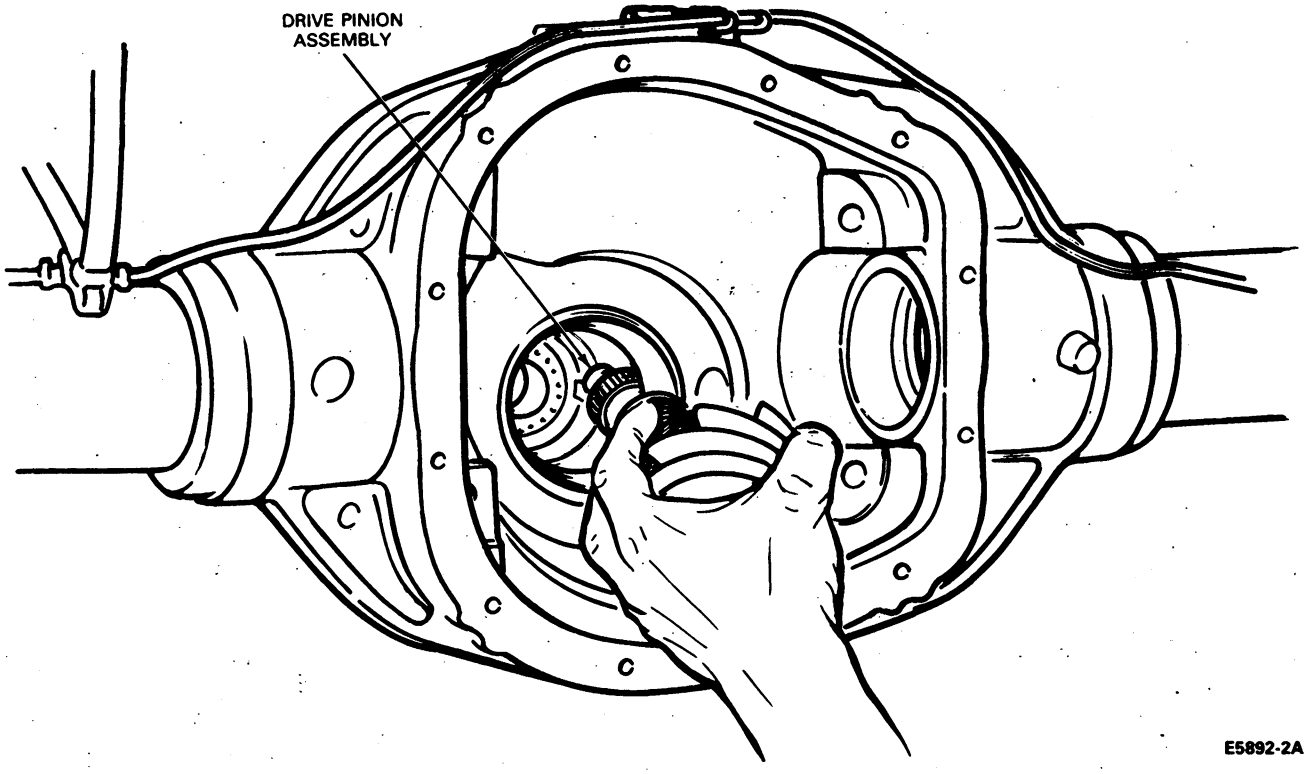
CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



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REMOVAL AND INSTALLATION (Continued)

10. From the rear of the axle housing, install the drive pinion assembly (drive pinion, shim(s), rear bearing cone and roller, and collapsible spacer) into the housing pinion shaft bore.



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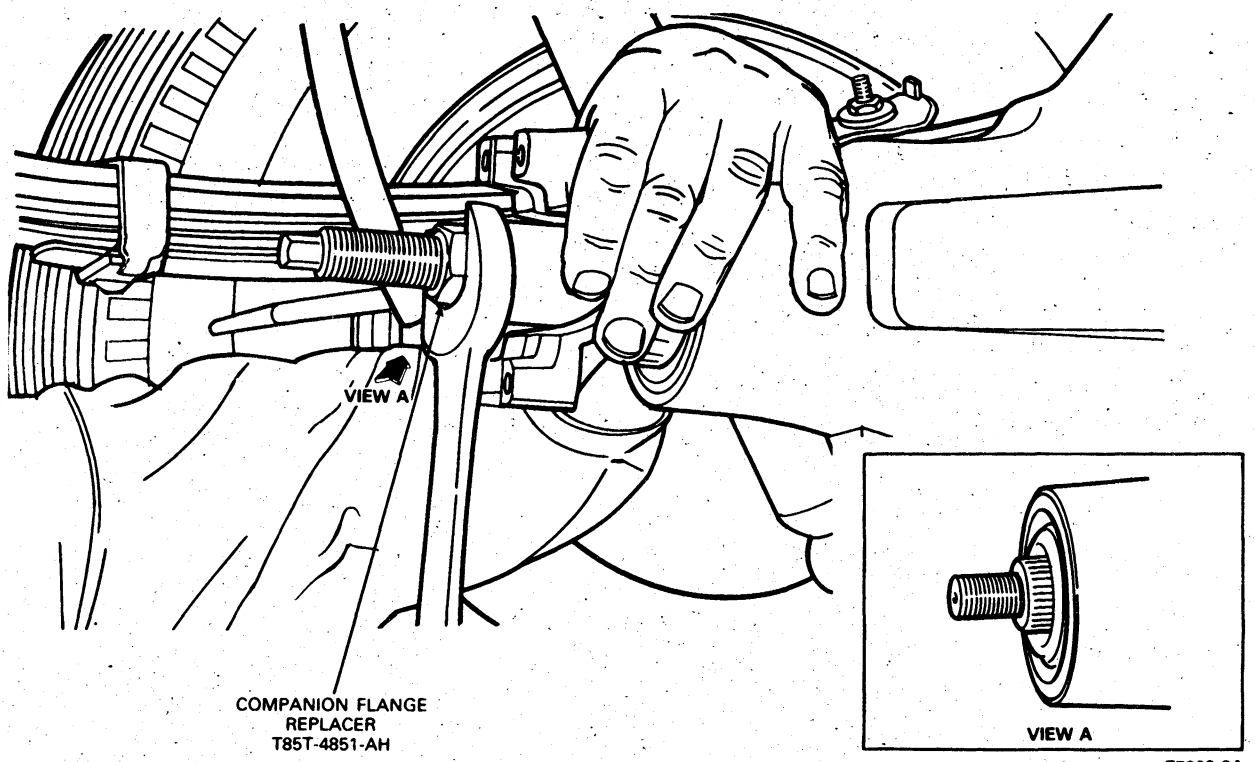
REMOVAL AND INSTALLATION (Continued)

11. Apply a small amount of lubricant to the companion flange shaft splines. Align the mark on the companion flange with the mark on the pinion stem.

    With the drive pinion in place in the housing, install companion flange using Companion Flange Replacer, T85T-4851-AH or equivalent.

NOTE: If a new companion flange is being installed, disregard the scribe mark on the pinion stem.

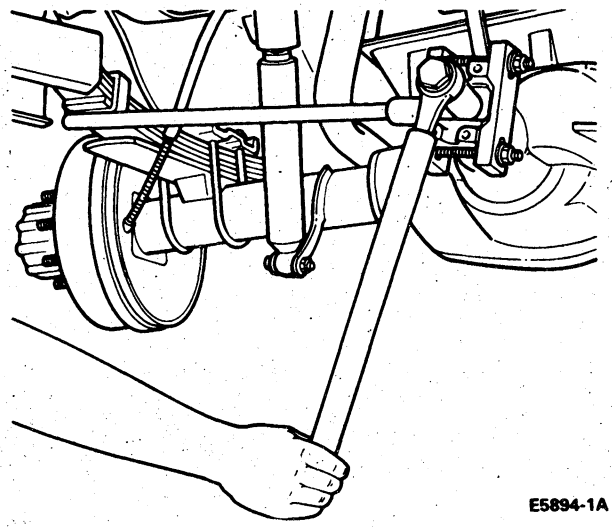
NOTE: The companion flange must never be hammered on or installed with power tools.



E5893-2A

12. Hold the companion flange with Companion Flange Holding Tool, T57T-4851-B or equivalent while tightening the nut.

Tighten the pinion nut (minimum torque of 217 N·m or 160 ft-lbs), rotating the pinion occasionally to insure proper bearing seating. Take frequent pinion bearing torque preload readings until the original recorded preload reading is obtained by rotating the pinion with an inch pound torque wrench.



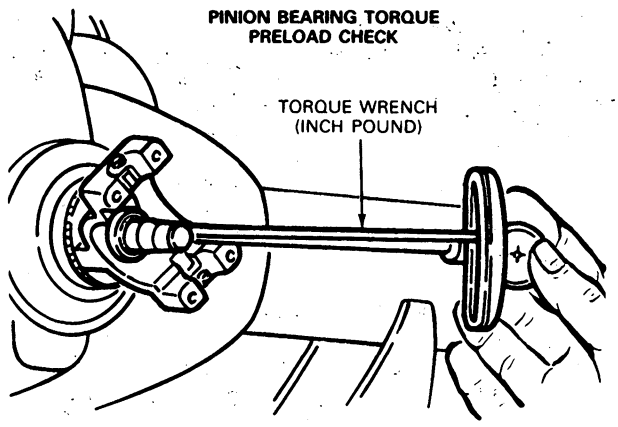
E5894-1A

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REMOVAL AND INSTALLATION (Continued)

If the original recorded preload is lower than specification (original bearings .9-1.5 N·m [8-14 in-lbs]; new bearings 1.8-3.3 N·m [16-29 in-lbs]), tighten to specification. If the preload is higher than specification, tighten to original reading as recorded.

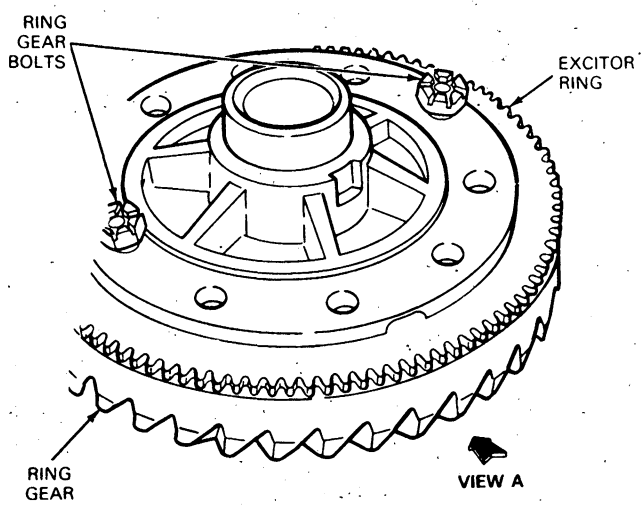
Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.

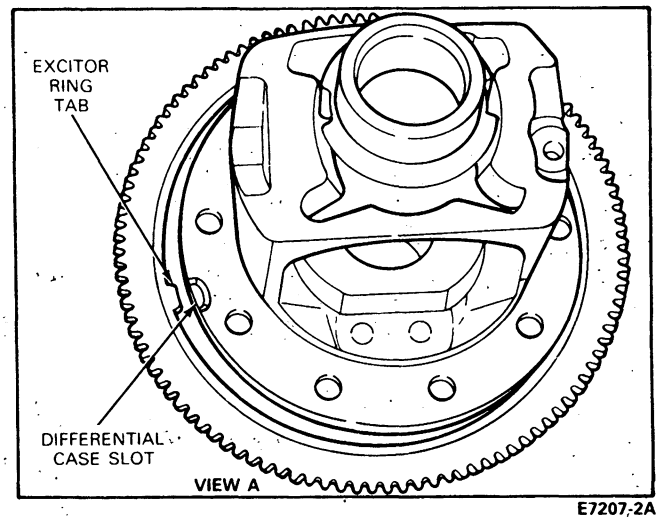


E5895-1A

13. Align tab in excitor ring with slot in differential case. Start two ring gear bolts through the case into the ring gear to ensure case to ring gear bolt hole alignment.

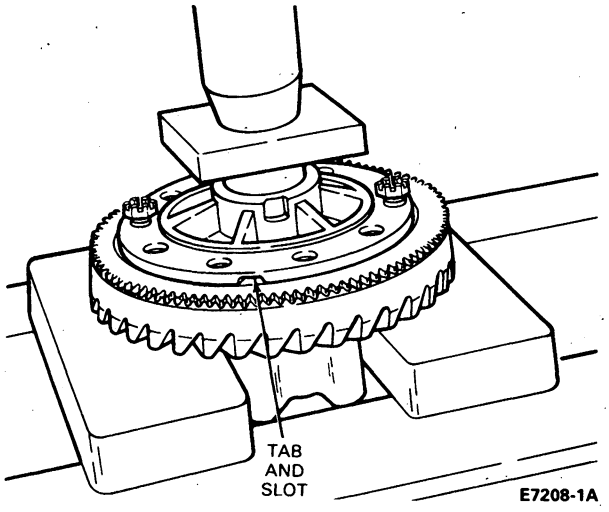
CAUTION: Tab on excitor ring must be aligned with slot in differential case.





E7207-2A

14. Press the excitor ring and ring gear on the differential case. The ring gear acts as a pilot for the excitor ring. Apply Loctite E0AZ-19554-B or equivalent to ring gear bolts and tighten to 135-162 N·m (100-120 ft-lbs).

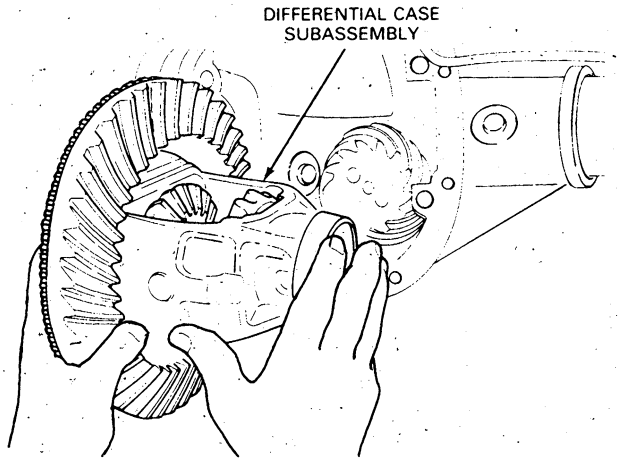


E7208-1A

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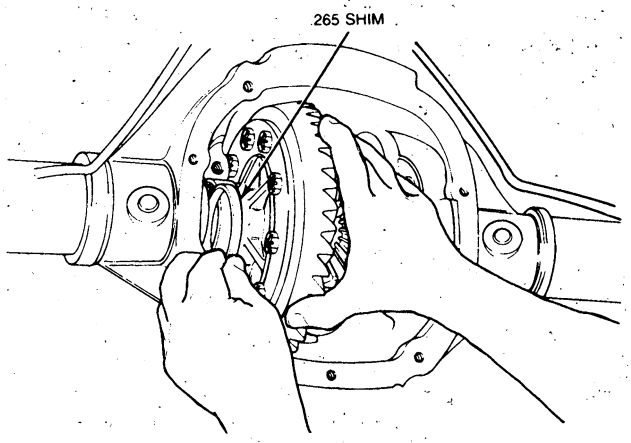
REMOVAL AND INSTALLATION (Continued)

15. With pinion depth set and pinion installed, place differential case subassembly (with ring gear, excitor ring, thrust washers, side gears, bearings and cups) in carrier.



E4749-1B

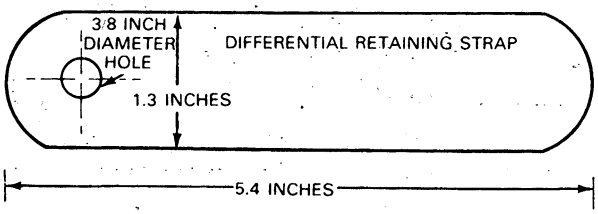
16. Install a 0.265 inch shim on left side.



E4750-1A

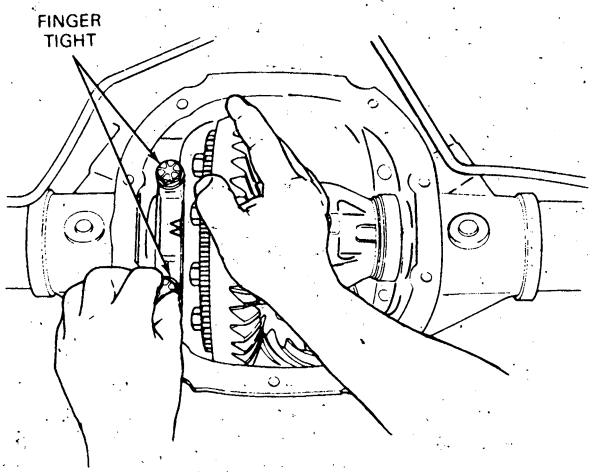
NOTE: To simplify installation, fabricate two differential case retaining straps from metal stock as shown. These retaining straps will prevent the differential from falling out of the housing.

Attach the straps at the 11 o'clock and 1 o'clock positions in the cover bolt holes. Install bolts and rotate straps to contact the bearing cups. Make sure access is available for shim installation.



E5896-1A

17. Install left bearing cap and tighten bolts finger tight.



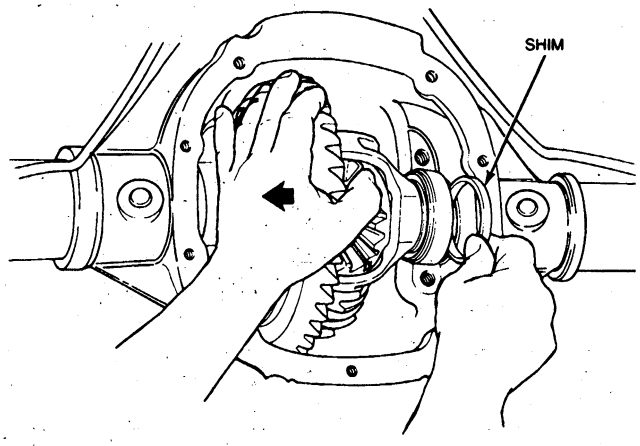
E4751-1B

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REMOVAL AND INSTALLATION (Continued)

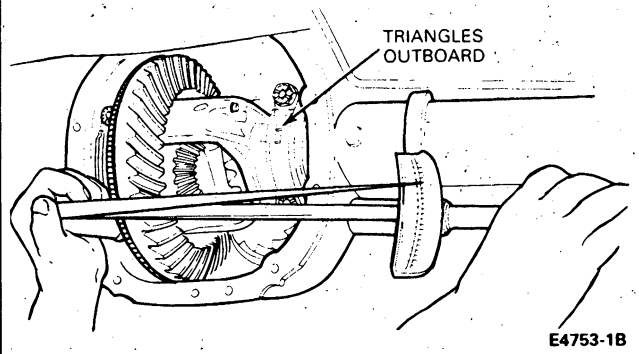
18. Install progressively larger shims on the right side until the largest shim selected can be installed by hand.

NOTE: Apply pressure towards left side to insure that the left bearing cup is seated.



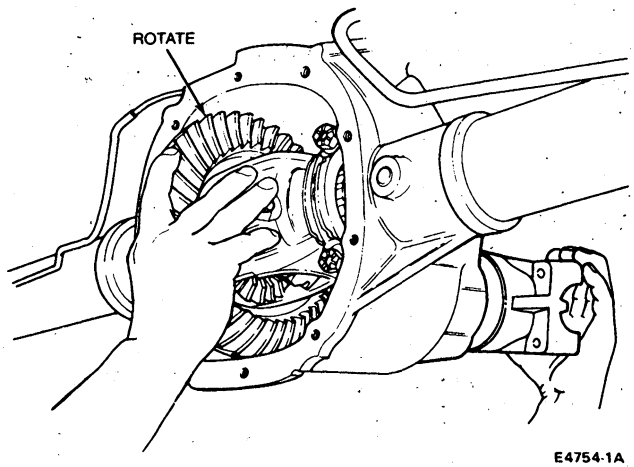
E4752-1A

19. Install right side bearing cap and tighten bearing cap bolts to 95-115 N·m (70-85 ft-lbs).



E4753-1B

20. Rotate assembly to insure free rotation.



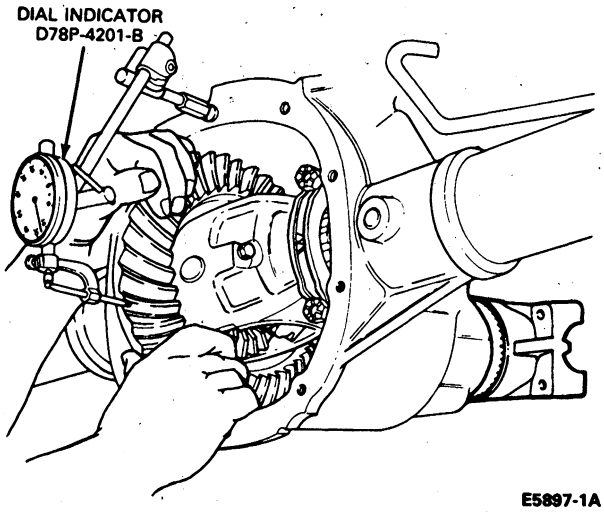
E4754-1A

21. Check ring gear and pinion backlash with a Dial Indicator, D78P-4201-B.

If the backlash is 0.008-0.015 inch (0.012-0.015 inch preferred), proceed to Step 27.

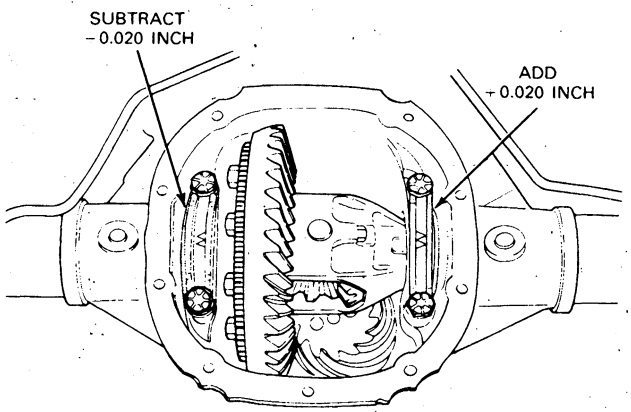
If the backlash is zero, proceed to Step 21.

If the backlash is 0.001-0.007 inch or greater than 0.015 inch, proceed to Step 23.



E5897-1A

22. If a zero backlash condition occurs, add 0.020 inch to the right side and subtract 0.020 inch from the left side.



E4756-1A

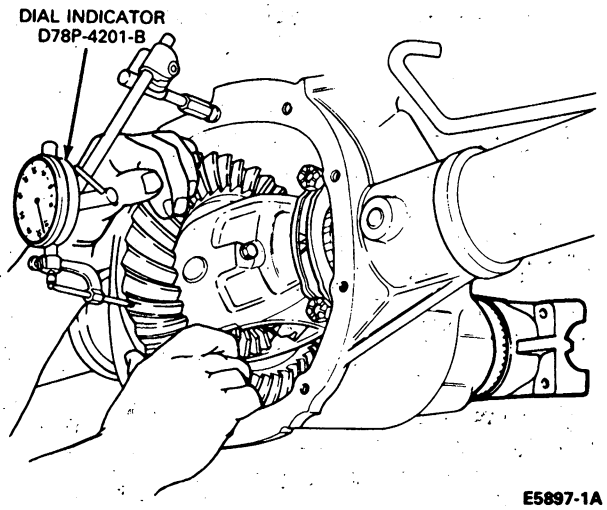
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REMOVAL AND INSTALLATION (Continued)

23. Recheck backlash.

    If backlash is within specification, go to Step 28.

    If backlash is not within specification, proceed to Step 24.

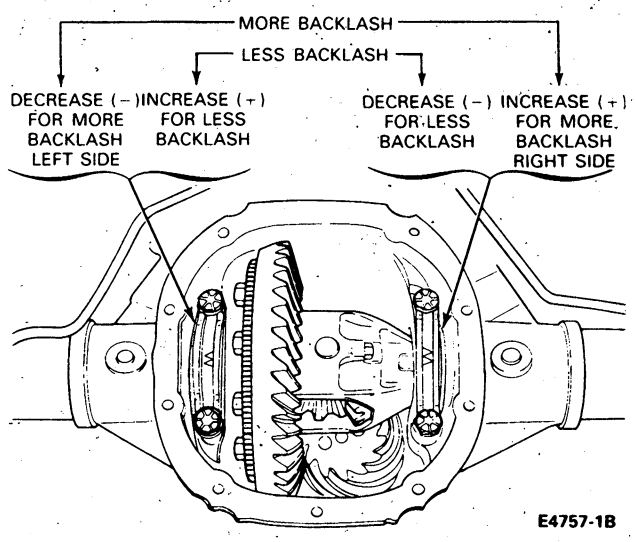


E5897-1A

24. If backlash is 0.001-0.007 inch, or greater than 0.015 inch, correct backlash by increasing thickness of one shim and decreasing thickness of the other shim by the same amount. Refer to chart for approximate shim change.

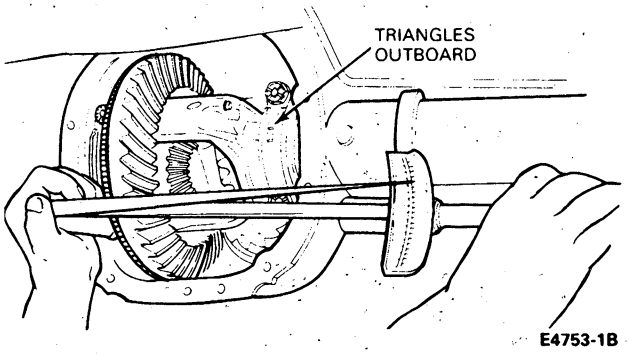
Backlash Change Required	Thickness Change Required	Backlash Change Required	Thickness Change Required
.001	.002	.009	.012
.002	.002	.010	.014
.003	.004	.011	.014
.004	.006	.012	.016
.005	.006	.013	.018
.006	.008	.014	.018
.007	.010	.015	.020
.008	.010		

CE5113-1A



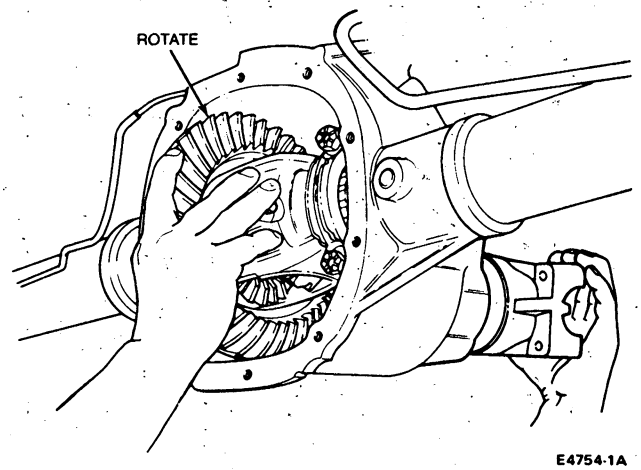
E4757-1B

25. Install shim and bearing caps. Tighten cap bolts to 109-128 N·m (80-95 ft-lbs).



E4753-1B

26. Rotate assembly several times to insure proper seating of differential bearings.



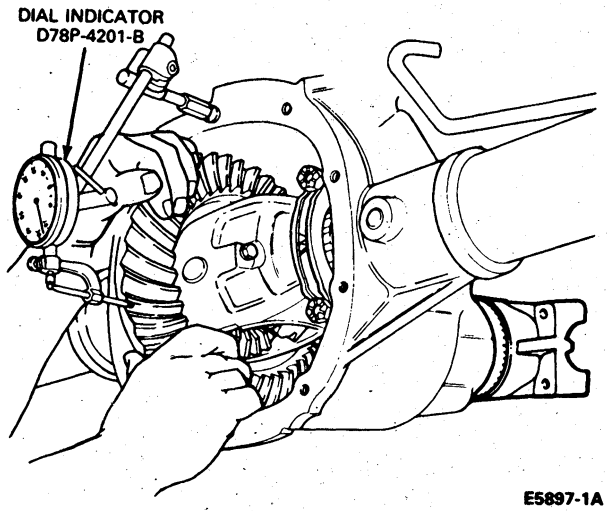
E4754-1A

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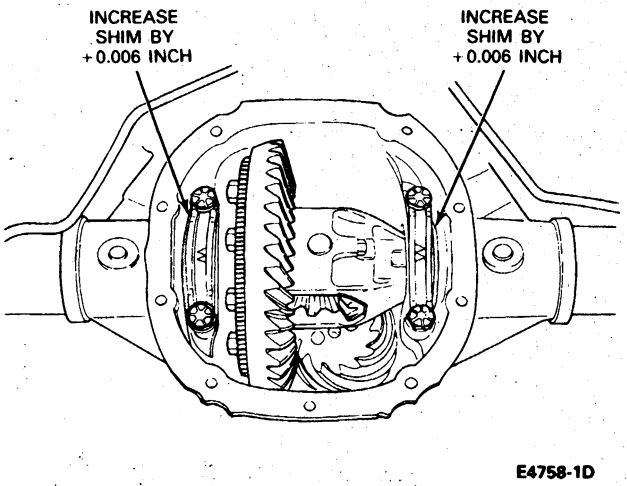
REMOVAL AND INSTALLATION (Continued)

27. Recheck backlash. If backlash is within specification, go to Step 28. If backlash is not within specification, repeat Step 24.

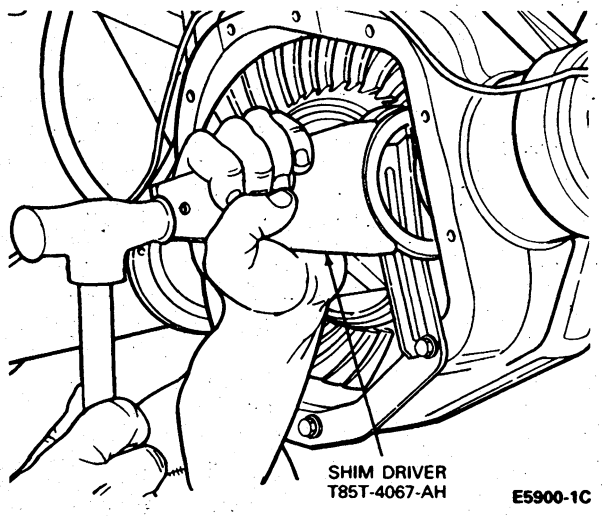
    Backlash Specification: 0.008 inch to 0.015 inch. Preferred range: 0.012 inch to 0.015 inch.



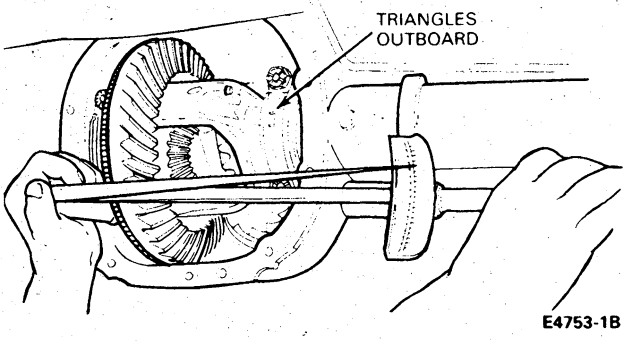
28. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.006 inch. Make sure shims are fully seated and assembly turns freely.



    Install the shims by driving into position with Shim Driver, T85T-4067-AH.



29. Install bearing caps and tighten cap bolts to 109-128 N·m (80-95 ft-lbs). Recheck backlash. If not to specification, repeat Step 20.



30. Install the driveshaft in the extension housing. Align the scribe marks on the axle companion flange and driveshaft and connect the driveshaft.

    Tighten attaching bolts and nuts to 11-20 N·m (8-15 ft-lbs).

31. Install the axle shafts and axle housing cover as described under Axle Shafts in the Removal and Installation portion of this Section.

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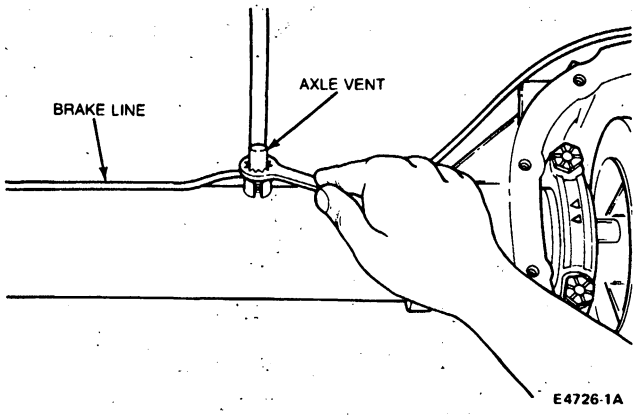
REMOVAL AND INSTALLATION (Continued)

Axle Housing

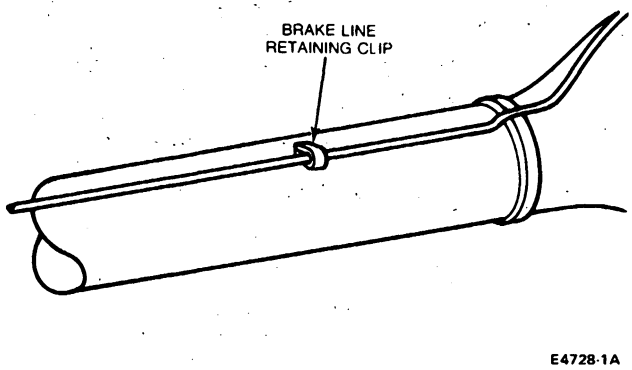
Removal

1. Raise the vehicle and install safety stands. Remove the rear wheels and tires and the brake drums.
2. Mark the driveshaft axle end flange and the axle companion flange to insure proper position of the driveshaft during assembly. Disconnect the driveshaft from the rear axle companion flange. Remove the driveshaft.
3. Remove axle shafts (semi-float axle) or hub (full-float axle).
4. Remove the four retaining nuts from each backing plate.
5. Disconnect the vent hose from the vent and the vent from the rear axle housing.

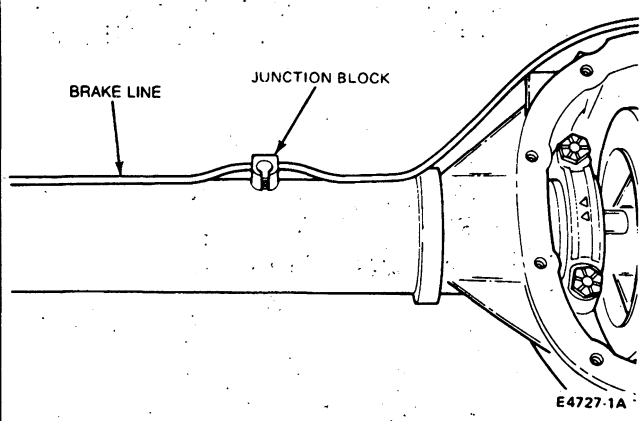
NOTE: The axle vent is secured to the housing assembly through the brake junction block.



6. Disengage the brake line from the clips that retain the line to the axle housing and carrier.



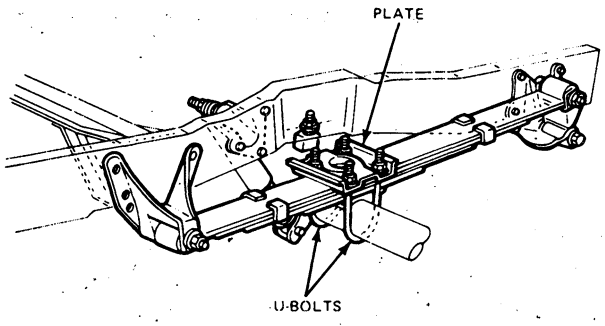
7. Remove the hydraulic brake junction block from the axle housing. **Do not open the hydraulic brake system lines.**

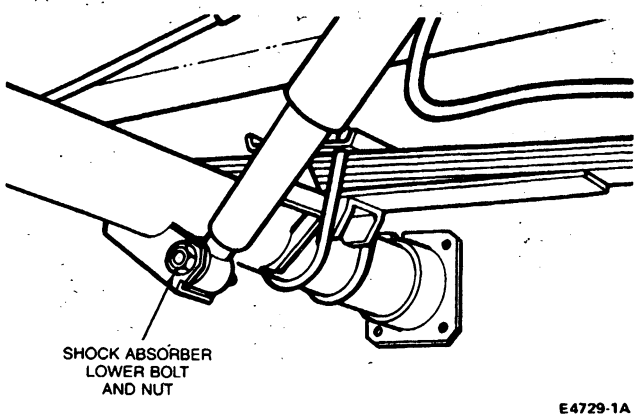


8. Support the rear axle housing on a jack, and then remove the U-bolt nuts. Remove the U-bolts and plates.

   Disconnect the shock absorber lower bolts from the mounting brackets on the axle housing.

   Remove the housing from the vehicle.



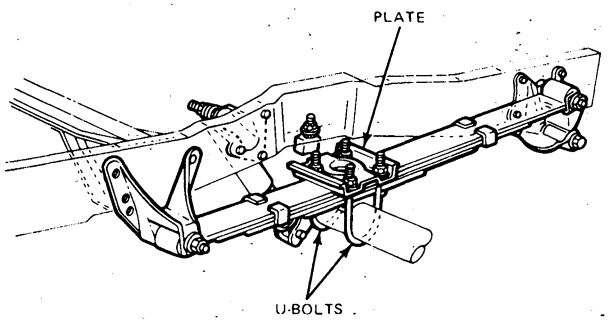


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REMOVAL AND INSTALLATION (Continued)

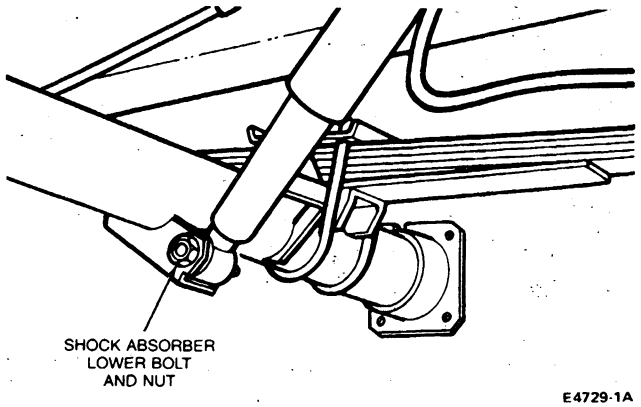
Installation

1. Raise the axle housing into position so that the U-bolt plates can be installed. Tighten the U-bolt nuts to the specification listed in Section 14-31, Rear Suspension—Leaf Springs. (There are different specifications, depending on the vehicle.)



E4730-1A

2. Connect the shock absorber lower bolts to the mounting bracket on the axle housing. Install the attaching nuts and tighten to the specification listed in Section 14-31, Rear Suspension—Leaf Springs.



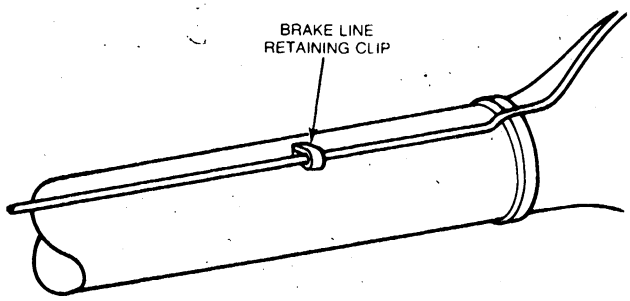
E4729-1A

3. Insert the vent fitting into the hydraulic junction block and position the assembly over the housing vent hole. Hand start the vent fitting and tighten to 20 N·m (15 lbs-ft).

   Position the brake lines to the axle housing and secure with the retaining clips at the right hand axle tube and vent fitting through the junction block.

   Install the brake backing plates on the axle housing flanges (no gaskets required). Tighten the attaching bolts to 68-115 N·m (50-85 ft-lbs).

4. Align the scribe marks on the axle companion flange and driveshaft and connect the driveshaft. Tighten attaching bolts and nuts to 11-20 N·m (8-15 ft-lbs).
5. Install the brake drums.
6. Install the wheel and tire. Tighten the wheel lug nuts to specification. Install the wheel covers.



E4728-1A

Rear Antilock Brake System Sensor

Removal

1. Remove Sensor Hold Down Bolt. Remove sensor.
2. Clean axle mounting surface, using caution to prevent dirt from entering axle housing.

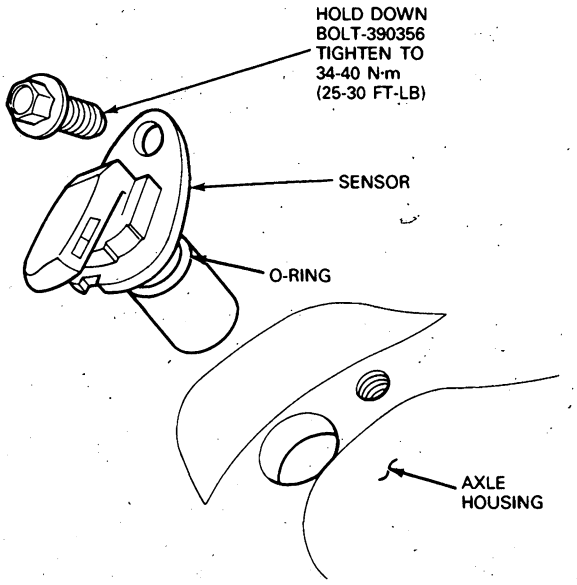
Installation

1. If new sensor is to be installed, lightly lubricate O-ring with motor oil.
   a. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
   b. Install Hold Down Bolt and tighten to 34-40 N·m (25-30 ft-lb).
2. If old sensor is to be reinstalled, clean and blow off metal particles using shop air.
   a. Remove and replace O-ring with a new O-ring.
   b. Apply a light film of motor oil to O-ring.
   c. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.

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REMOVAL AND INSTALLATION (Continued)

d. Install Hold Down Bolt and tighten to 34-40 N·m (25-30 ft-lb).

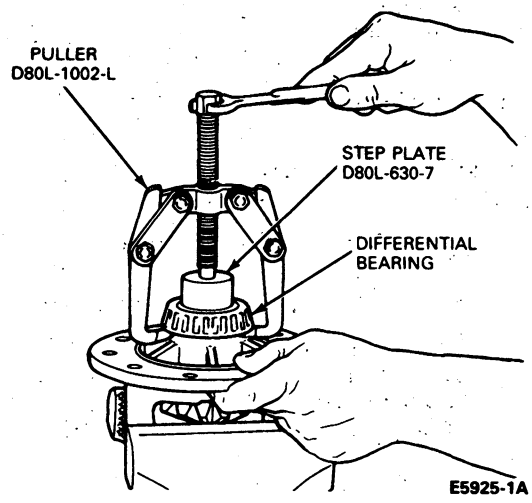


DISASSEMBLY AND ASSEMBLY

Differential Case

Disassembly

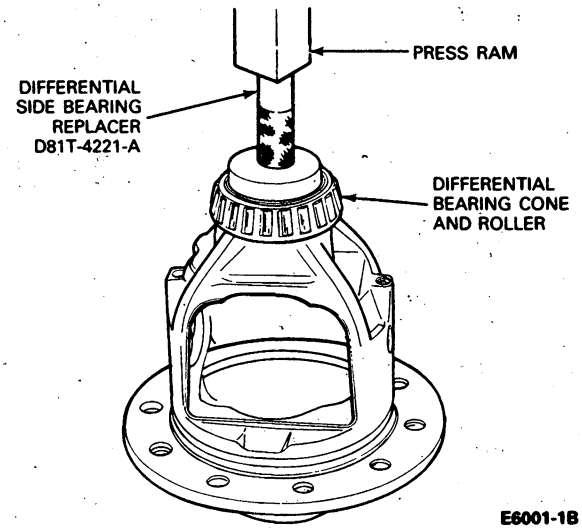
1. If required, remove the ring gear, excitor ring, side gears, pinion gears and thrust washers.
2. Remove the differential case from the housing and remove the differential bearings from the case using Puller, D80L-1002-L or equivalent.



Assembly

1. Install differential bearings on the case hubs using Differential Bearing Cone Replacer, D81T-4221-A.

NOTE: Press against the bearing cone only.



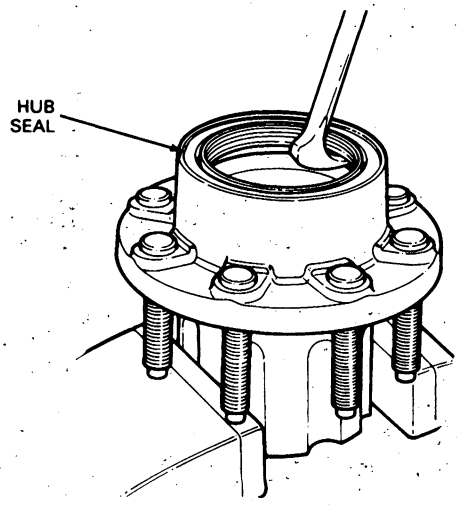
2. Press the ring gear and excitor ring onto the differential case, and install the attaching bolts. Tighten the bolts to 135-162 N·m (100-120 ft-lbs).

CAUTION: Before performing this Step, refer to ring gear/excitor ring installation procedures in this Section.

Hub—Full Floating Axle Only

Disassembly

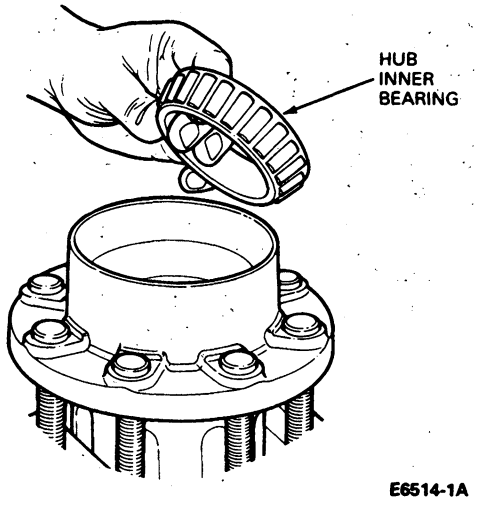
1. Install hub in soft jawed vise.
2. Remove hub seal.



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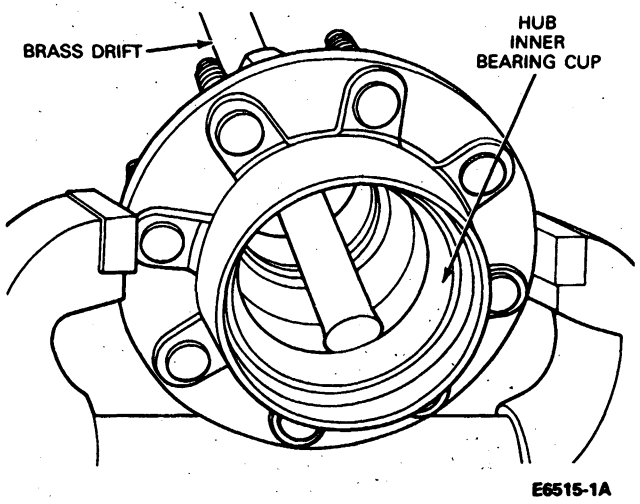
DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove hub inner bearing.

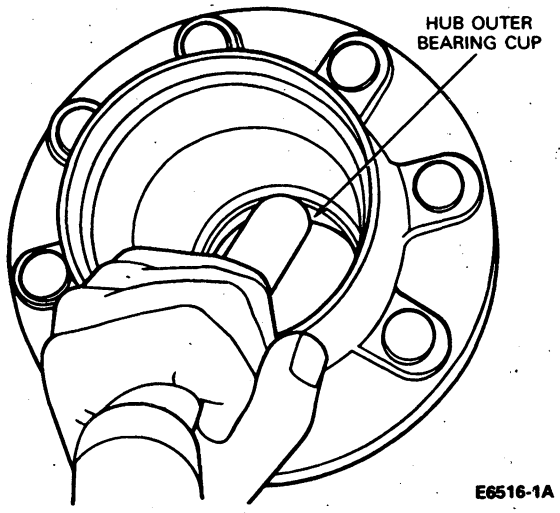


4. Re-position the hub in the vise and remove the hub inner bearing cup with a brass drift.

CAUTION: Make sure hub is secure in vise.



5. Re-position the hub in the vise and remove the hub outer bearing cup with a brass drift.



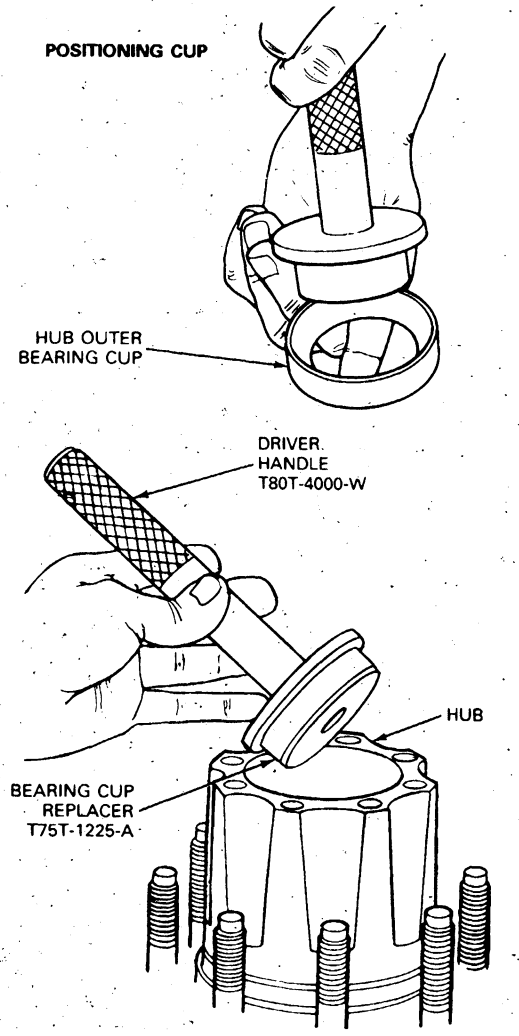
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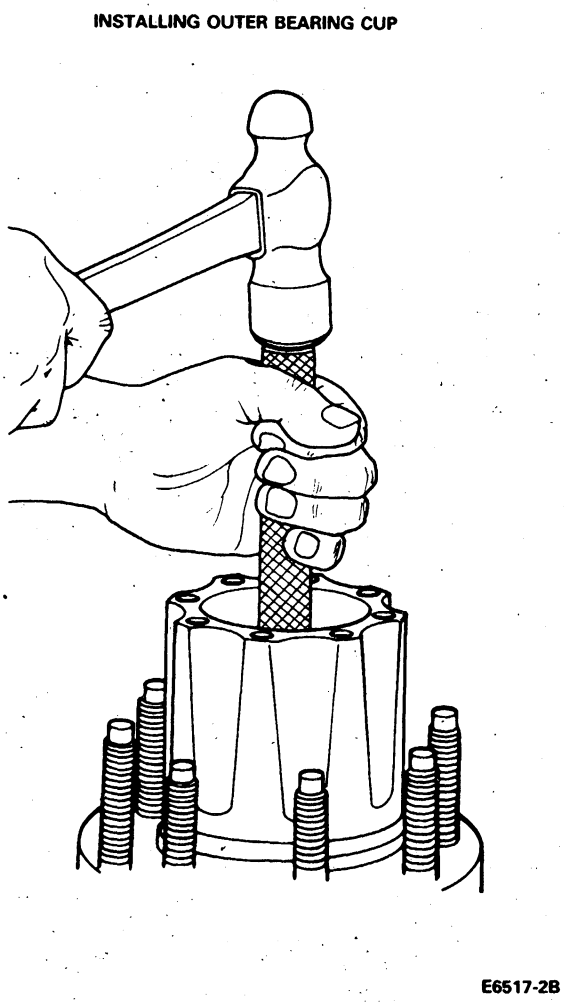
DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

1. Place the outer bearing cup in the hub.
2. Insert tool squarely into hub and strike handle until outer bearing cup is seated.

CAUTION: Bearing cup replacer must be held straight during installation to assure proper seating of bearing cup.





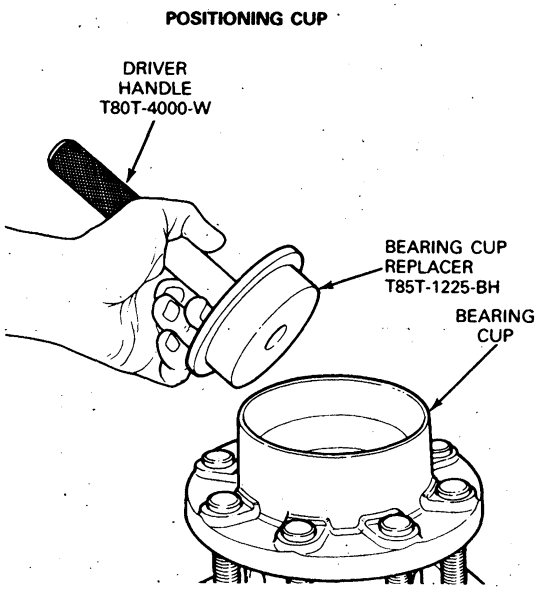
E6517-2B

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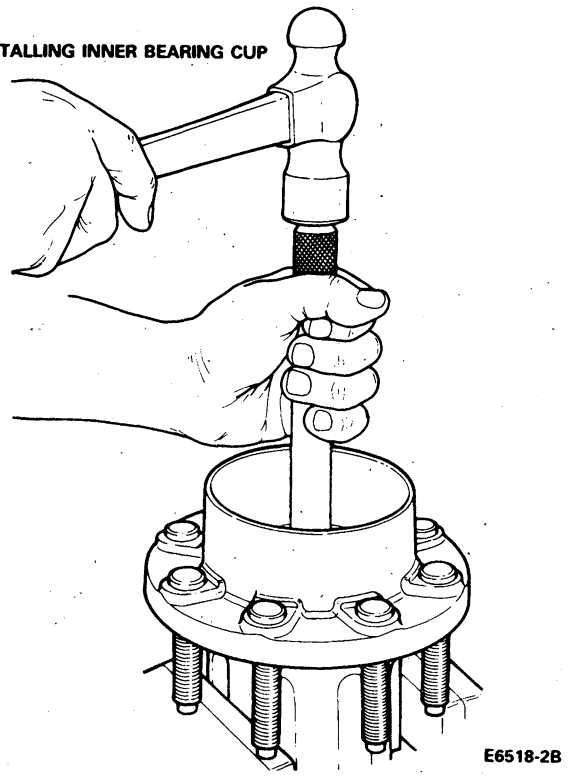
DISASSEMBLY AND ASSEMBLY (Continued)

3. Place the inner bearing cup in the hub.
4. Insert tool squarely into hub and strike handle until inner bearing cup is seated.

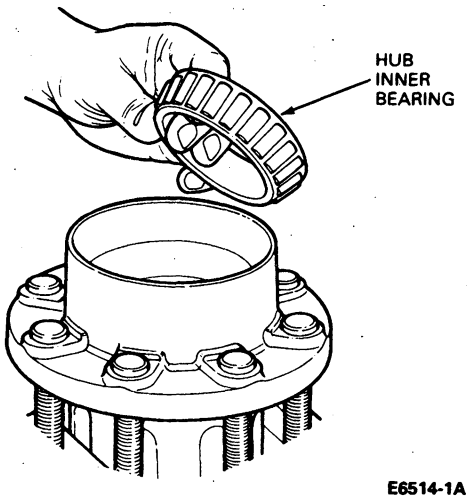
CAUTION: Bearing cup replacer must be held straight during installation to assure proper seating of bearing cup.



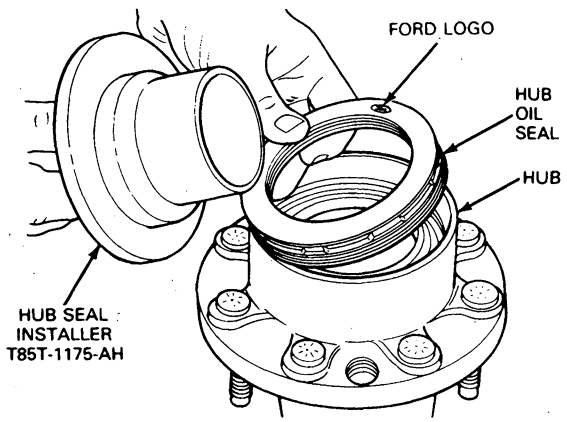
HUB **INNER** BEARING CUP INSTALLATION



5. Place hub inner bearing in the cup.



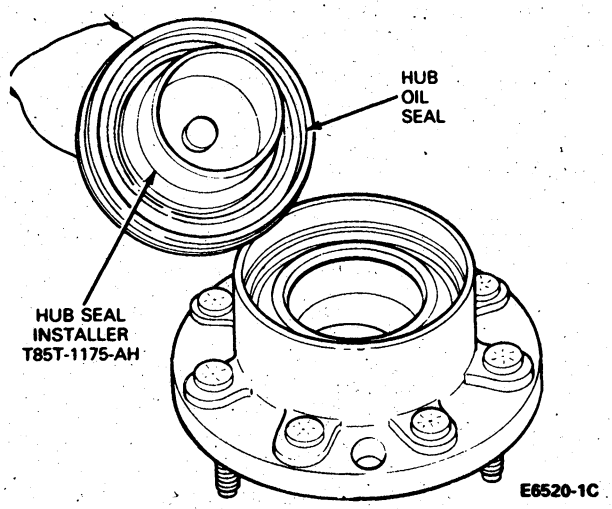
6. Install seal in hub with Ford logo facing up.



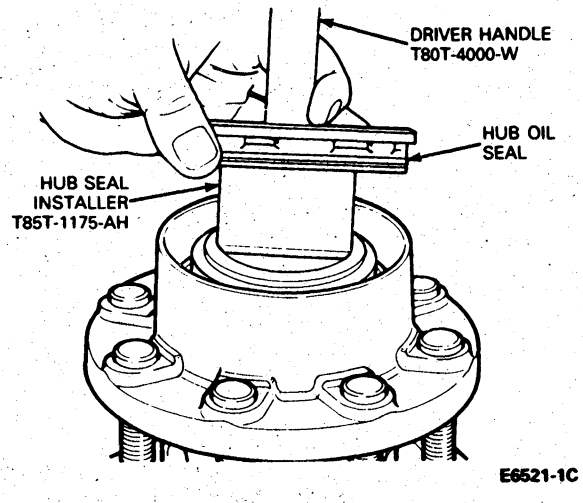
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DISASSEMBLY AND ASSEMBLY (Continued)

7. Install hub oil seal on Hub Seal Installer Tool.



8. Insert tool with seal squarely into hub.

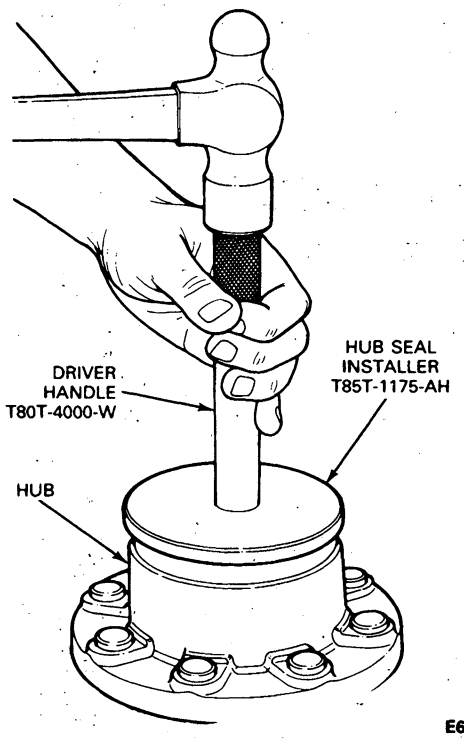


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DISASSEMBLY AND ASSEMBLY (Continued)

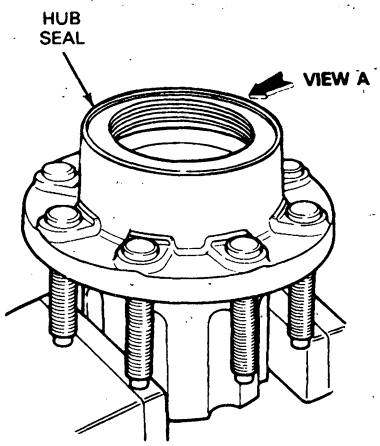
9. **Hold tool straight.** Strike handle until hub seal is fully seated (until tool strikes hub).

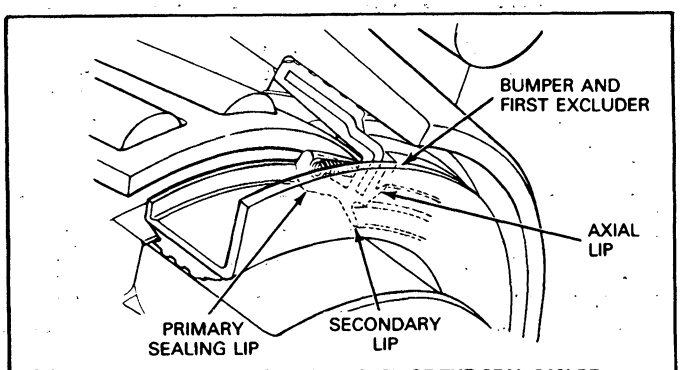
CAUTION: Install new seal if seal is misaligned during or after installation.



E6522-1C

Unitized wheel seals are standard items on full floating rear axles. The unitized wheel seal combines the function of a wear sleeve and the seal in one self-contained unit with the seal and sleeve surface inside. The unitized design provides maximum protection for the sealing surface during installation and operation.





NOTE: THE FLANGED INNER METAL PART OF THE SEAL CAN BE MOVED IN AND OUT OF THE OUTER SEAL FREELY. THIS DESIGN FEATURE PREVENTS IT FROM BINDING AGAINST THE OIL SEALING LIP DURING OPERATION.

VIEW A

E6523-2B

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SPECIFICATIONS

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL CARRIER)

Description	Torque (In-Lb) N·m	Torque (Ft-Lb) N·m
Minimum torque required to tighten pinion flange nut to obtain correct pinion bearing preload	—	(160)① 217
Pinion Bearing Preload — (Collapsible Spacer)		
Used Bearings	(8-14) 0.9-1.5	—
New Bearings —	(16-29) 1.8-3.3	—

①If pinion bearing preload exceeds specification before this torque is obtained, install a new collapsible spacer. CE5904-1C

TORQUE SPECIFICATIONS (INTEGRAL CARRIER)

Description	Torque N·m	Torque (Ft-Lb)
Differential Bearing Cap Bolt	109-129	80-95
Differential Pinion Shaft Lock Bolt①	20-40	15-30
Ring Gear Attaching Bolts①	135-162	100-120
Rear Cover Screw	34-47	25-35
Oil Filler Plug	20-40	15-30
Brake Backing Plate Nuts — E-250, F-250	68-95	50-70
Driveshaft to Axle Companion Flange	11-20	8-15
Axle Vent	20	15
Wheel Lug Nut (Both Single and Dual Rear Wheel)	190	140
RABS Sensor Bolt	34-40	26-30

①Using Loctite E0AZ-19554-B (or equivalent) CE5905-1D

DRIVING AXLE APPLICATION AND IDENTIFICATION FULL-FLOATING AXLES (INTEGRAL CARRIER)

"F" Series Truck — Full Float

Identification Tag	Ratio	Conventional Differential	Limited-Slip Differential	Single Rear Wheel	Dual Rear Wheel
125C	3.55:1	X		X	
126C	3.55:1	X		X	
129C	4.10:1	X		X	
130C	4.10:1	X		X	
131C	4L10:1		X	X	
132C	4L10:1		X	X	
166C	3.55:1	X			X
168C	4.10:1	X			X
169C	4L10:1		X		X
170C	4.10:1	X			X
171C	4L10:1		X		X

"F" Series Truck — Chassis Cab — Full Float

Identification Tag	Ratio	Conventional Differential	Limited-Slip Differential	Dual Rear Wheel
186C	3.55	X		X
190C	4.10:1	X		X
191C	4L10:1		X	X
183C	3.55:1	X		X
189C	4.10:1	X		X
192C	4.10:1		X	X

CE6526-2D

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SPECIFICATIONS (Continued)

SPECIAL SERVICE TOOLS

Tool Number	Description	Tool Number	Description
T50T-100-A	Impact slide Hammer	T80T-4020-F42	Pinion Depth Gauge Block
D80L-630-7	Step Plate	T80T-4020-F43	Pinion Depth Gauge Screw
D80L-1002-L	Puller	D81T-4020-F51	Pinion Depth Gauge Tube
D81L-1002-A	Puller	T85T-4067-AH	Shim Driver
T75L-1165-B	Axle Bearing/Seal Plate	D78P-4201-B	Dial Indicator
T75T-1225-A	Bearing Cup Replacer-Outer	T85T-4209-AH	Pinion Shaft Thread Protector
T85T-1175-AH	Hub Seal Installer	T57L-4221-A	Differential Side Bearing Replacer
T85T-1225-AH	Bearing Remover	D81T-4221-A	Differential Bearing Cone Replacer
T85T-1225-BH	Bearing Cup Replacer — Inner	T85T-4252-AH	Hub Wrench
D81L-4000-A	Driver Handle	D81T-4616-A	Pinion Bearing Cup Installer
T80T-4000-W	Driver Handle	T85T-4616-AH	Pinion Bearing Cup Installer
T80T-4000-X	Rear Axle Bearing Replacer	T71P-4621-B	Pinion Bearing Cone Remover
T80T-4000-Y	Rear Axle Shaft Seal Replacer	T85T-4621-AH	Pinion Bearing Cone Installer
T76P-4020-A11	Pinion Depth Gauge Handle	T83T-4676-A	Pinion Seal Replacer
T85T-4020-AH1	Aligning Adapter	T57T-4851-B	Companion Flange Holding Tool
T85T-4020-AH2	Gauge Disc	T85T-4851-AH	Companion Flange Replacer

CE5903-2B

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER)

Vehicle	Axle	Approximate Lubricant Capacity (In-Vehicle Repair)①②		
		U.S. Pints	Imperial Pints	Liters
F-250, F-350 Regular & Chassis CAB, F-250/350 H.D.	10-1/4 Inch Ring Gear	6.5③④	5.4	3.0

① All conventional Axles use Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent.
② For out-of-vehicle repair, use 7.5 U.S. Pints (6.2 imperial pints, 3.5 Liters)
③ Below bottom of filler hole with vehicle in running position.
④ Plus 8 oz. (U.S. measure) additive friction modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent for limited-slip applications. CE6524-2B

TORQUE SPECIFICATION — FULL FLOATING AXLE ONLY

Description	Torque	
	N·m	(Ft-Lbs)
Hub Nut	75-88①	55-65①
Wheel Lug Nut (both Single & Dual Rear Wheel)	190	140
Axle Shaft Bolts	82-108	60-80

①Before ratcheting back 5 notches. CE6525-1B

F-SERIES TRUCK — SEMI-FLOAT APPLICATION AND IDENTIFICATION

Identification Tag	Ratio	Conventional Differential	Limited-Slip Differential	Single Rear Wheel
106C	3.55:1	X	—	X
110C	4.10:1	X	—	X
107C	3.55:1	—	X	X
111C	4.10:1	—	X	X

CE5902-1D

CLEARANCE, TOLERANCE AND ADJUSTMENTS (INTEGRAL CARRIER)

Description	Inches
Maximum Runout of Back Face of Ring Gear	0.004
Maximum Runout of Back Face of Differential Case Flange	0.003
Differential Side Gear Thrust Washer Thickness	0.030-0.032
Differential Pinion Gear Thrust Washer Thickness	0.030-0.032
Nominal Pinion Locating Shim	0.030
Available Pinion Gear Shims in Steps of 0.001 Inch	0.021-0.037
Backlash Between Ring Gear & Pinion Teeth	0.008-0.015 (0.012-0.015 Preferred)
Maximum Backlash Variation Between Teeth	0.004
Maximum Radial Runout of Companion Flange in Assembly	0.012 T.I.R.
Sensor Pole to Top of Exciter Ring Gap	0.005-0.045

CE5118-1C

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SECTION 15-32 Front Driving Axle—Dana Model 60 Monobeam

SUBJECT	PAGE
ADJUSTMENTS	
Front Wheel Bearing Adjustment	15-32-2
DESCRIPTION AND OPERATION	
Front-Wheel Drive Free-Running Hub	15-32-1
DIAGNOSIS AND TESTING	15-32-2
DISASSEMBLY AND ASSEMBLY	
Assembly of Differential Into Housing	15-32-28
Axle Shaft	15-32-34
Depth Gauge Check	15-32-25
Differential Case	15-32-21
Gear Tooth Contact Pattern Check	15-32-32
Pinion, Drive Gear and Differential Case Carrier	15-32-16
DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Pinion Bearing Cup Installation	15-32-25
Pinion Bearing Preload and Final Depth Check	15-32-26
REMOVAL AND INSTALLATION	
Axle Shaft	15-32-2
Drive Pinion Oil Seal	15-32-15
Front Axle	15-32-11
Steering Knuckle and Upper and Lower Kingpins	15-32-7
SPECIFICATIONS	15-32-36
VEHICLE APPLICATION	15-32-1

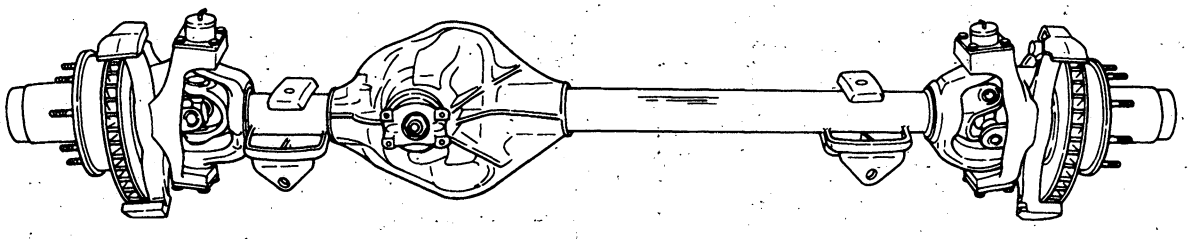
VEHICLE APPLICATION

All to F-350 (4x4) vehicles.

DESCRIPTION AND OPERATION

Dana Model 60 monobeam front drive axle is used on the F-350 4x4 vehicles and has open yoke design.

Other than the unique parts required for front-wheel drive, these axles are mechanically identical to Model 60 rear axles. It should be noted that the manual locking hubs are standard.



DANA MODEL 60 MONOBEAM FRONT DRIVE AXLE

E6532-2A

Front-Wheel Drive Free-Running Hub

The free-running hub is standard equipment for the Dana 60 front axle on F-350 (4X4) vehicles. It is the internal locking type.

Lock Position

When the transfer case is to be shifted into the position for driving the front axle, the pointer on the center bar of the hub must point to the notch under the word LOCK on the hub lock cap. If the clutch teeth do not engage with the knob turned to this position, the clutch teeth are butted and a slight movement of the wheel in either direction will complete the lock. The front axle will now drive the wheels. Do not operate in four-wheel drive with the hubs disengaged.

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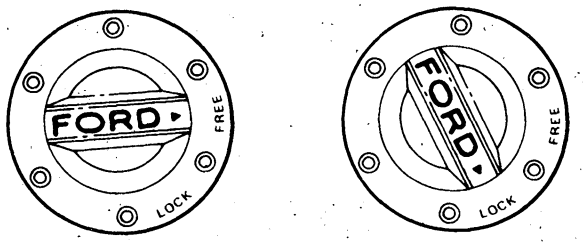
DESCRIPTION AND OPERATION (Continued)

Free-Running Position

When the transfer case is to be shifted into the position for driving the rear axle only, turn the pointer on the center bar of the hub so it points to the notch under the word FREE on the hub lock cap. This will disengage the clutch teeth and wheel hubs from the axle shafts. The wheels will turn freely on the axles.

Be certain that the transfer case is shifted into two-wheel drive position before disengaging the free-running hubs.

MANUAL LOCKING HUBS (STANDARD)



FREE RUNNING POSITION

LOCK POSITION

E4102-1D

DIAGNOSIS AND TESTING

Refer to Section 15-01, General Driving Axle Service, for diagnosis and testing procedures.

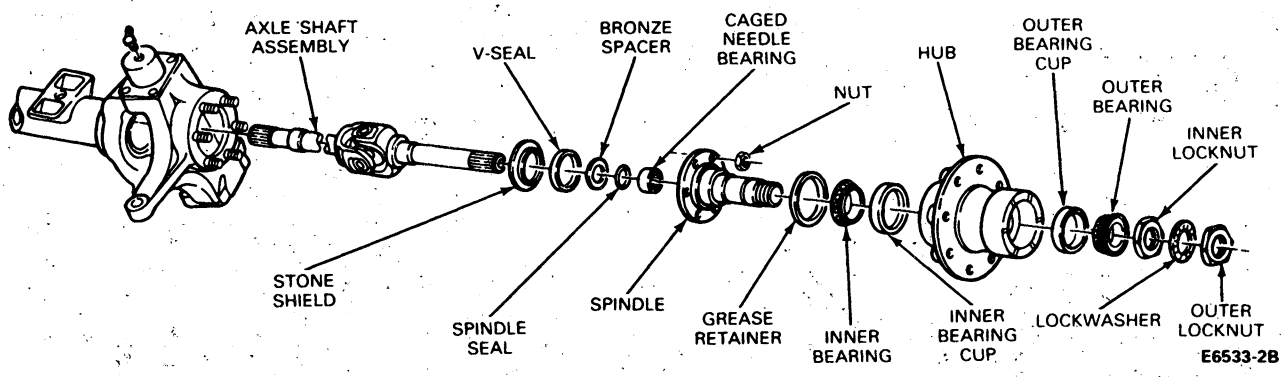
ADJUSTMENTS

Front Wheel Bearing Adjustment

Refer to Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive, for front wheel bearing adjustment procedures.

REMOVAL AND INSTALLATION

Axle Shaft



E6533-2B

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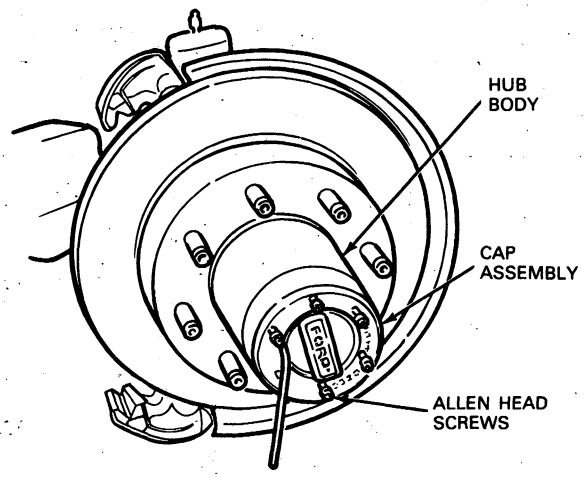
REMOVAL AND INSTALLATION (Continued)

Removal

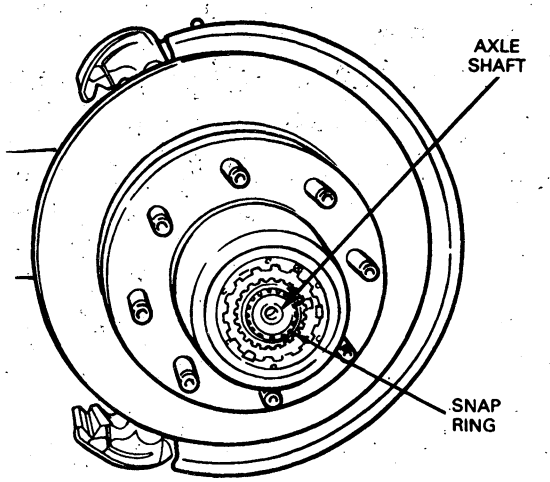
1. Raise the front of the vehicle and install safety stands.
2. Remove the lug nuts and remove the front wheel and tire assembly.
3. Remove the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. Securely wire the caliper to the frame.

CAUTION: After removal, the caliper must be wired to the frame or otherwise supported to prevent suspending the caliper by the flexible hose. If securing the caliper is not practical, disconnect and plug the hose to the caliper. Upon caliper installation, bleed the system as described in Section 12-01, General Hydraulic Brake Service.

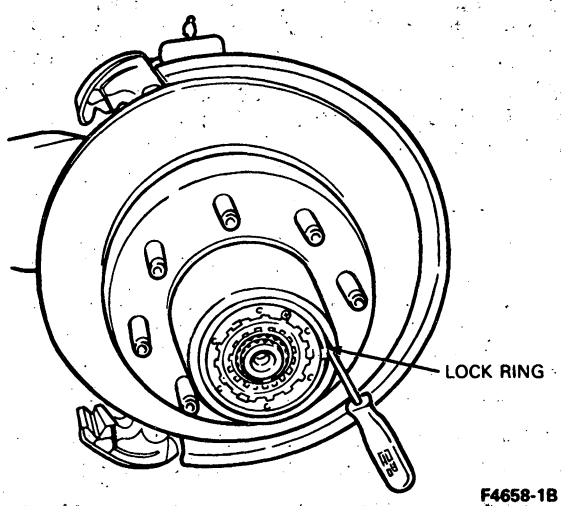
4. Remove the six allen-head capscrews retaining the cap to the hub body and remove the cap.



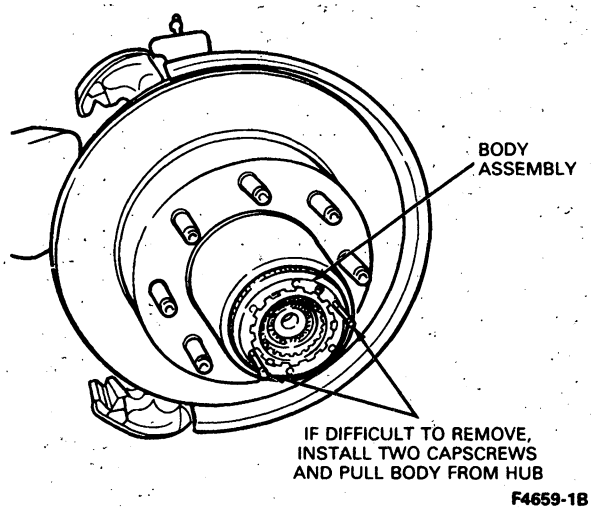
5. Remove the snap ring that retains the axle shaft in the hub body assembly.



6. Remove the lockring seated in the groove of the wheel hub.



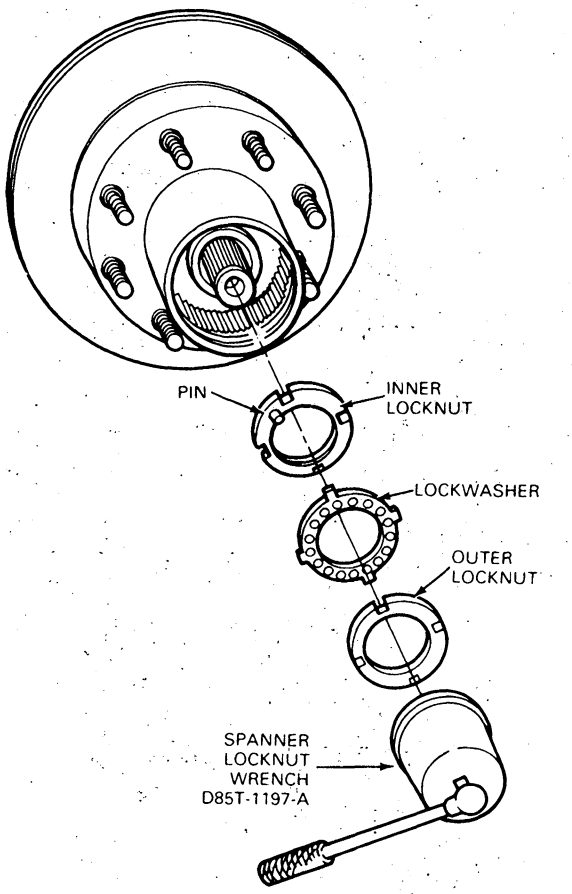
7. Remove the body assembly from the hub. If the body is difficult to remove, install two capscrews and pull the body assembly out of the hub.



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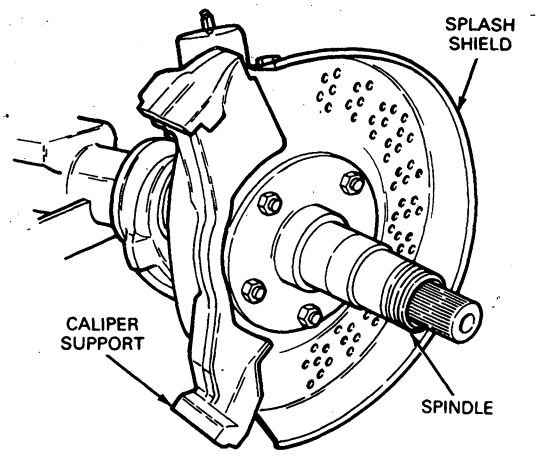
REMOVAL AND INSTALLATION (Continued)

8. Remove the outer locknut from the spindle with Spanner Locknut Wrench, D85T-1197-A or equivalent.
9. Remove the lockwasher from the spindle.
10. Remove the inner locknut from the spindle using Spanner Locknut Wrench, D85T-1197-A or equivalent.



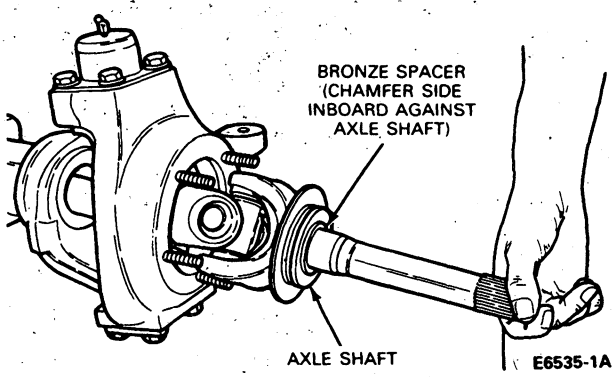
F4654-1A

11. Remove the hub and rotor assembly from the spindle.
12. Remove the nuts retaining the spindle to the knuckle. Lightly tap the spindle with a rawhide hammer to remove it from the knuckle.
13. Remove the splash shield and caliper support from the knuckle.



E6534-1A

14. Pull the axle shaft assembly out of the steering knuckle. If required, remove the bronze spacer from the axle shaft assembly.

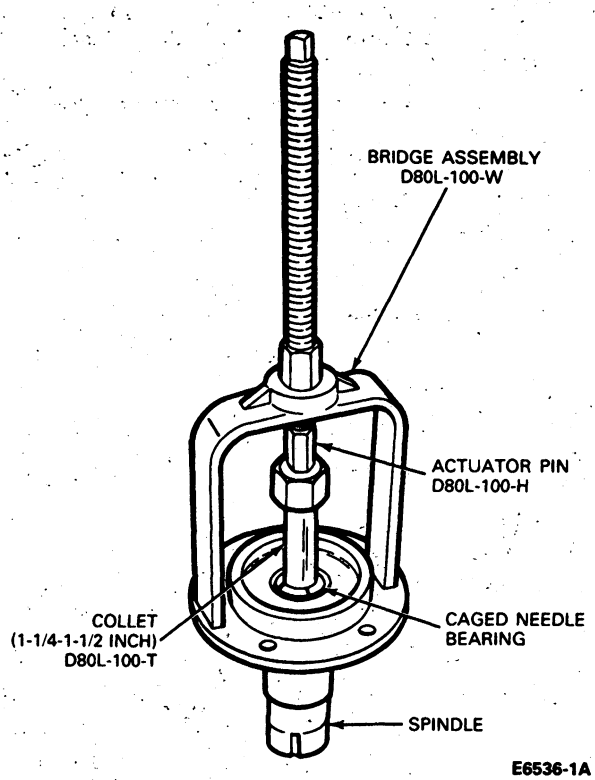


E6535-1A

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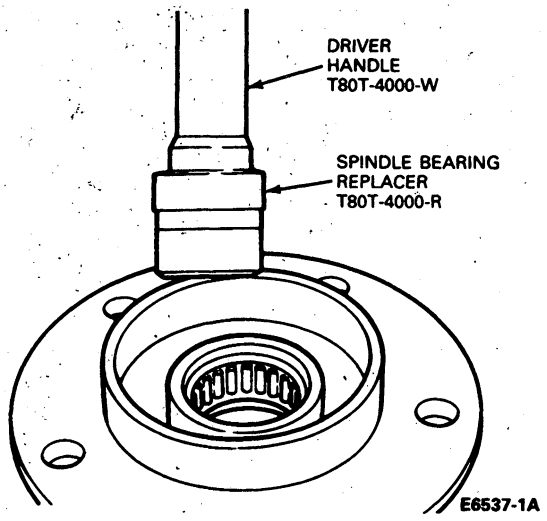
REMOVAL AND INSTALLATION (Continued)

15. If required, remove the caged needle bearing from the spindle. Remove the seal. Pull the bearing out of the spindle using Collet (1-1/2 to 1-3/4 inch), D80L-100-T, Actuator Pin, D80L-100-H and Bridge Assembly, D80L-100-W or equivalents.



Installation

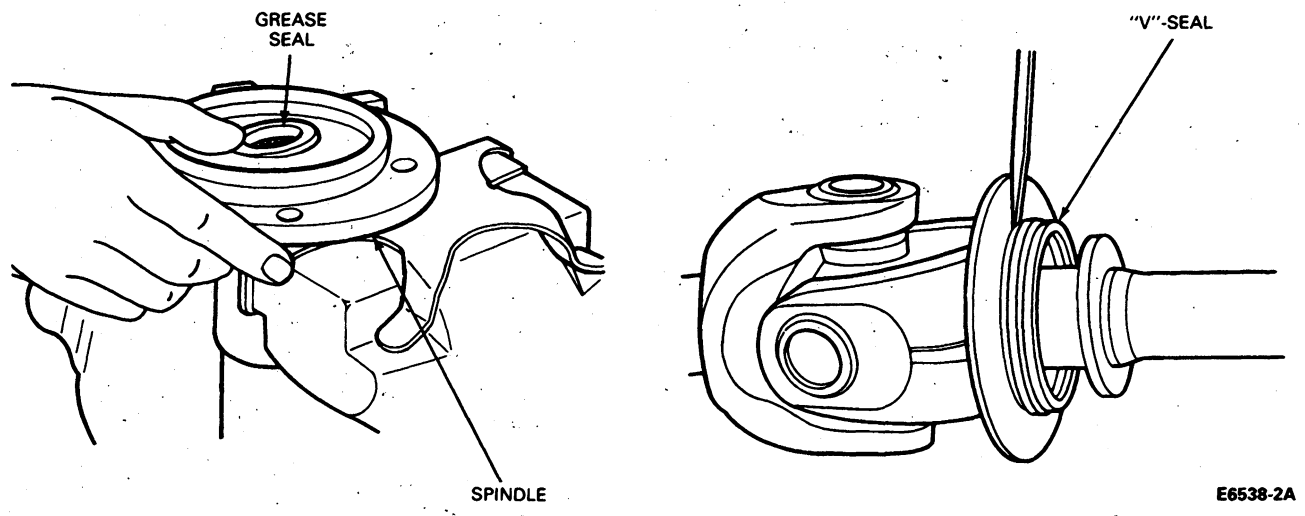
1. If removed, position a new caged needle bearing in the spindle bore. The writing on the bearing must face the rear of the spindle. Drive the bearing in the spindle with Spindle Bearing Replacer, T80T-4000-R and Driver Handle, T80T-4000-W or their equivalents. Pack the bearing with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Install the seal in the bore against the bearing.



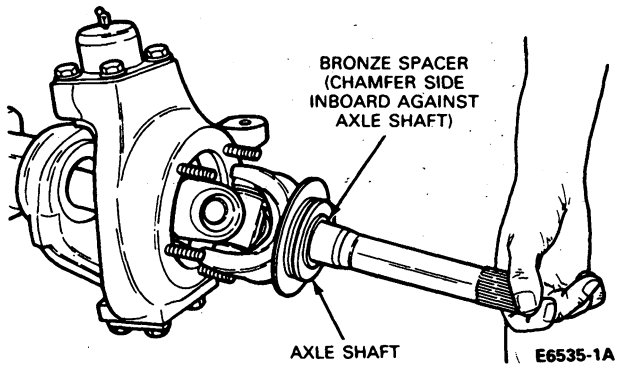
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REMOVAL AND INSTALLATION (Continued)

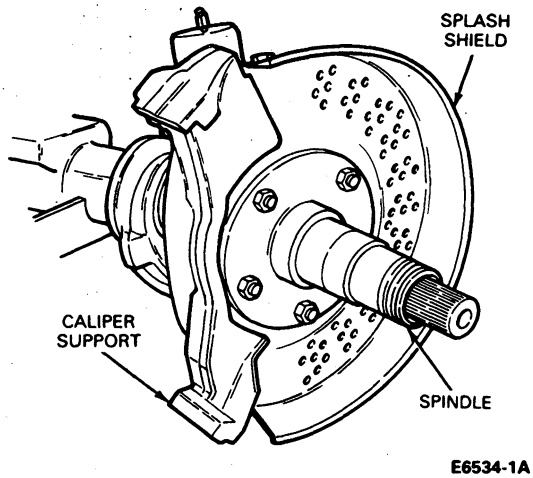
2. Pack the thrust face of seal in the spindle bore and the V-seal on the axle shaft with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.



3. Carefully guide the axle shaft through the knuckle and into the axle housing. Make sure that the axle shaft splines are engaged in the differential side gear splines.
4. Install the bronze spacer on the axle shaft assembly. The chamferred side of the spacer must be inboard against the axle shaft.



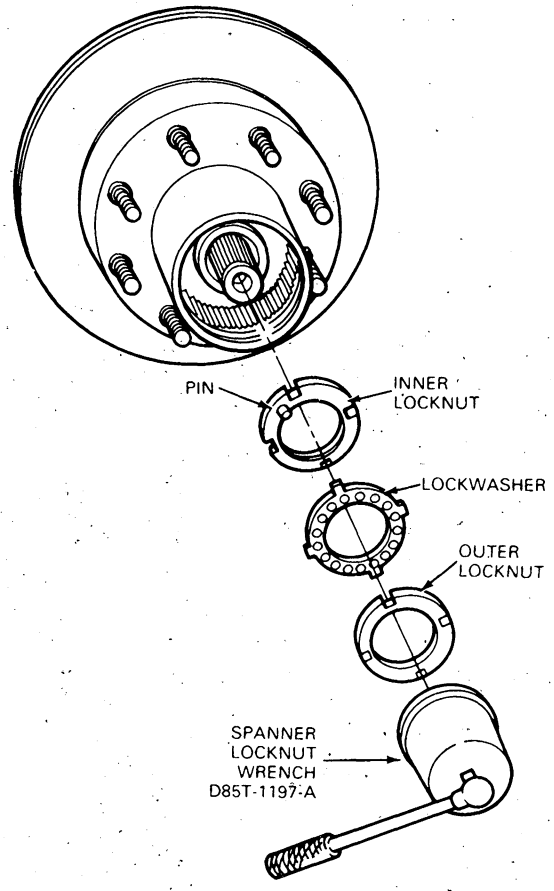
5. Install the splash shield and caliper support bracket on the steering knuckle.
6. Place the spindle on the steering knuckle. Install the nuts and tighten.



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REMOVAL AND INSTALLATION (Continued)

7. Install the hub and rotor assembly on the spindle.
8. Install the inner locknut on the spindle and seat the bearing by tightening the locknut to 68 N·m (50 ft-lb) with Spanner Locknut Wrench, D85T-1197-A or equivalent.
9. Back off the inner locknut and retighten to 41-54 N·m (31-39 ft-lb).
10. While rotating the hub and rotor, back off the locknut 135 to 150 degrees.
11. Install the lockwasher so the key is positioned in the spindle groove. Rotate the inner locknut so the pin is aligned into the nearest hole in the lockwasher.



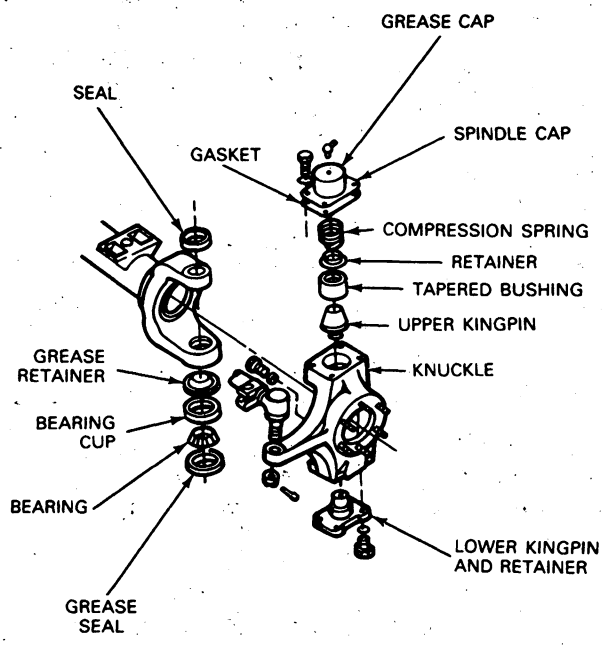
F4654-1A

12. Install the outer locknut and tighten to 217-278 N·m (160-205 ft-lb) using Spanner Locknut Wrench, D85T-1197-A.

NOTE: The final wheel bearing end play should be 0.00-0.15mm (0.000-0.006 inch).

13. Install the manual locking hub body assembly in the hub and rotor.
14. Install the lockring in the hub groove to retain the body in the hub.
15. Install the snap ring on the end of the axle shaft to retain the shaft to the body.
16. Position the cap assembly on the body. Install the six allen-head capscrews and tighten to 4.0-6.0 N·m (35-45 in-lb).
17. Install the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
18. Install the front wheel and tire assembly. Install the lug nuts and tighten to specification.

Steering Knuckle and Upper and Lower Kingpins



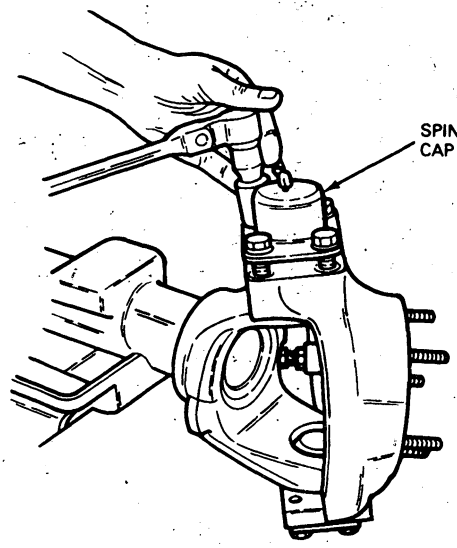
E6539-1A

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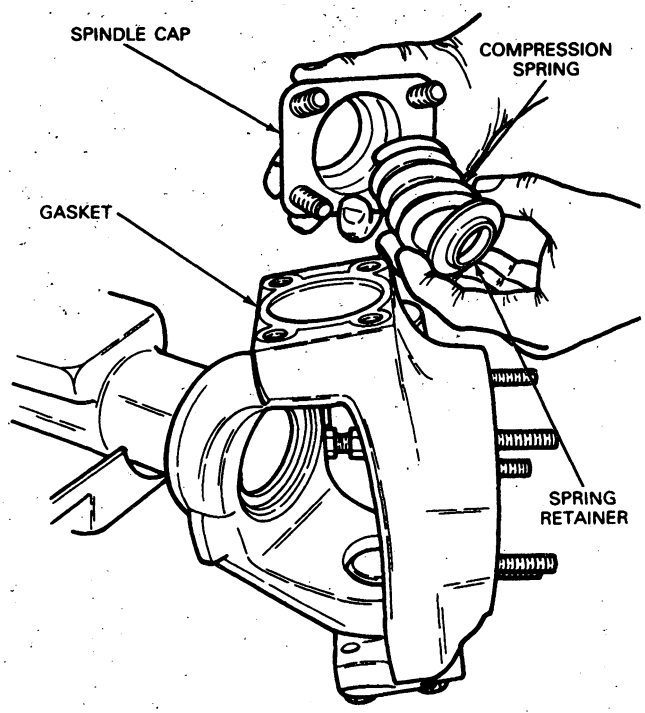
REMOVAL AND INSTALLATION (Continued)

Removal

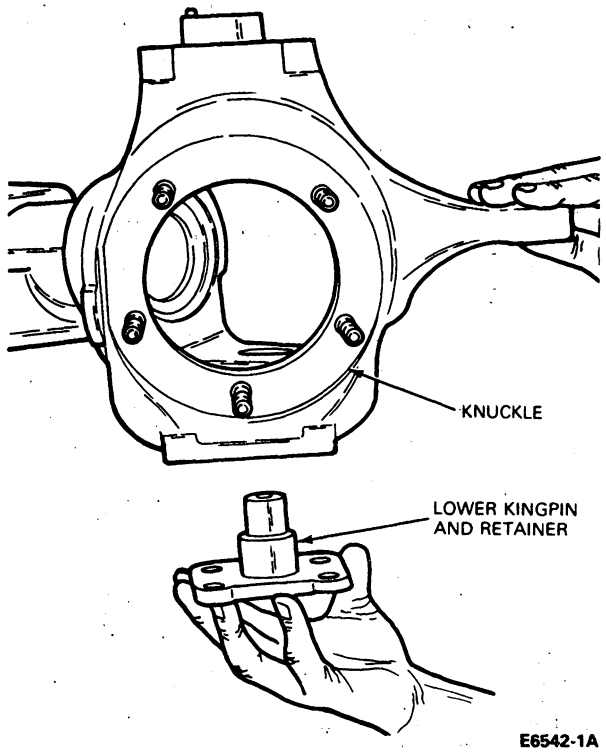
1. Remove the axle shaft as described under Axle Shaft in the Removal and Installation portion of this Section.
2. Alternately and evenly loosen the four bolts retaining the spindle cap to the knuckle. Loosening the bolts in this manner relieves the spring compression. Remove the bolts.



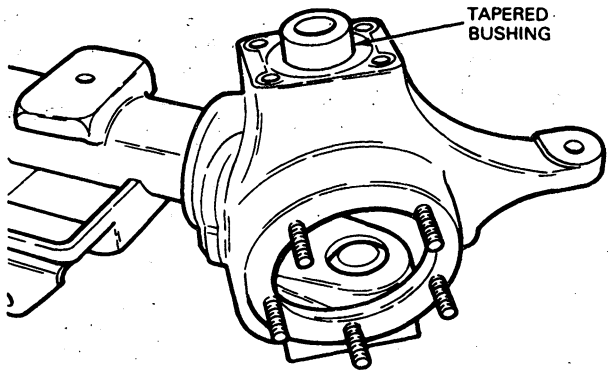
3. Remove the spindle cap, compression spring and retainer. Remove and discard the gasket.



4. Remove the four bolts retaining the lower kingpin and retainer to the knuckle. Remove the lower kingpin and retainer from the knuckle.



5. Remove the tapered bushing from the top of the upper kingpin in the knuckle. Remove the knuckle from the axle yoke.

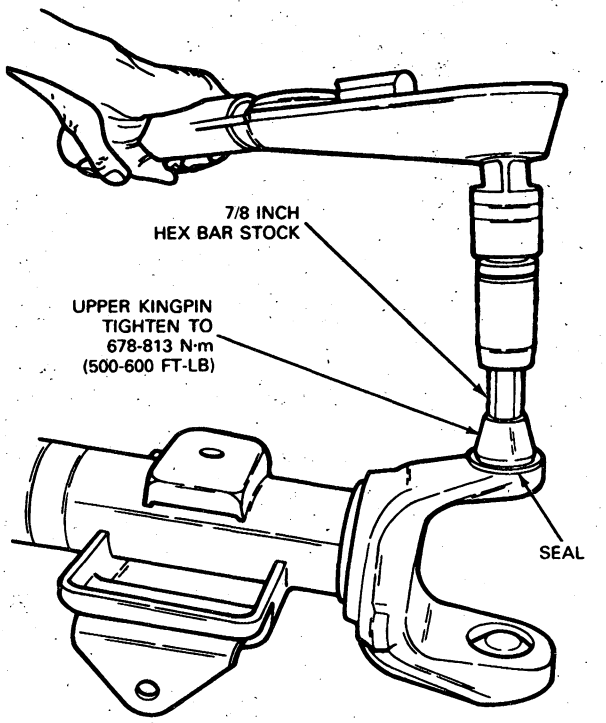


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REMOVAL AND INSTALLATION (Continued)

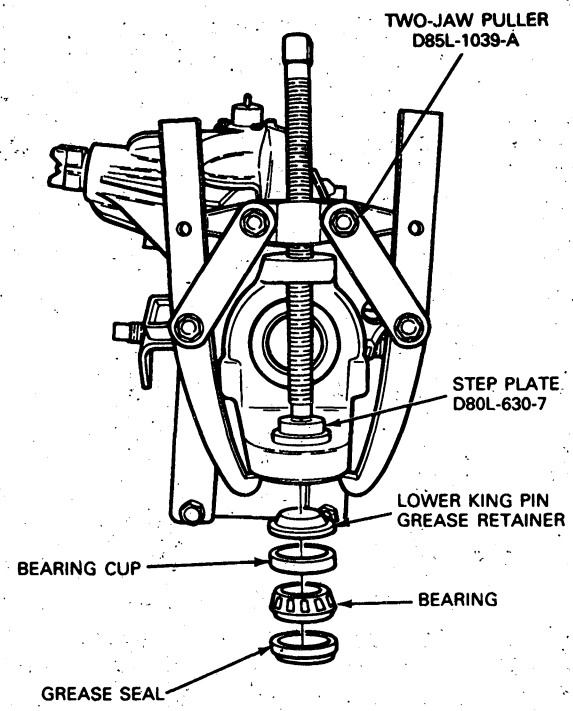
6. Remove the upper kingpin from the axle yoke with a piece of 7/8 inch hex-shaped case hardened metal stock or with 7/8 Inch Hex Socket, Snap-On, IMA-283 or equivalent. Discard the upper kingpin and seal.

NOTE: The upper kingpin is tightened to 678-813 N·m (500-600 ft-lb).



E6544-1A

7. Press the lower kingpin grease retainer, bearing cup, bearing and seal from the axle yoke lower bore with Two-Jaw Puller, D85L-1039-A and Step Plate, D80L-630-7 or equivalents. Discard the grease seal and retainer, and lower bearing cup.



E6545-1A

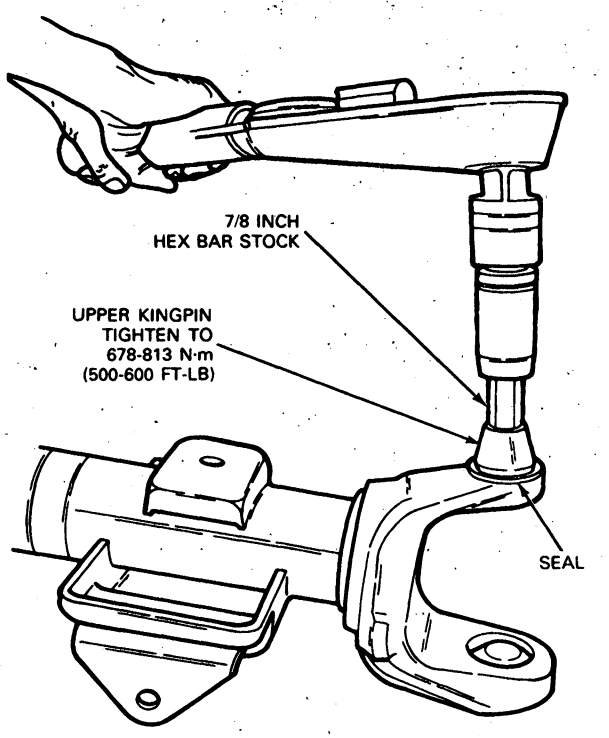
Installation

1. Coat the mating surface of a new lower kingpin grease retainer with RTV sealant such as Silicone Rubber, D6AZ-19562-AA or BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent.
2. Install the sealant covered lower kingpin grease retainer in the axle yoke bore so the concave portion of the retainer faces the upper kingpin.
3. With an appropriate driver, drive a new bearing cup in the lower kingpin bore until it bottoms against the grease retainer.
4. Pack the lower kingpin bearing and the yoke bore with Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-BA) or equivalent.
5. With an appropriate driver, drive a new seal in the lower kingpin bore.

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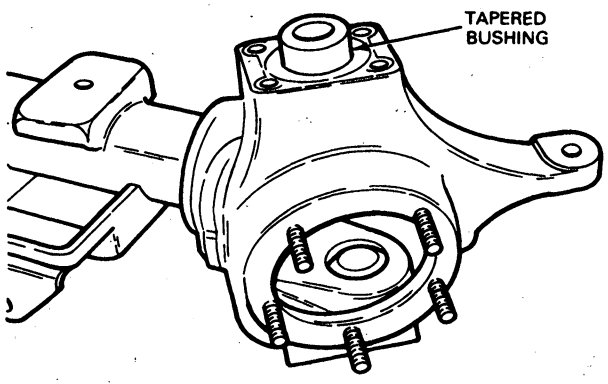
REMOVAL AND INSTALLATION (Continued)

6. Install a new seal, using Kingpin Seal Installer T86T-3110-AH or equivalent. Install upper kingpin assembly in the yoke. Tighten the kingpin to 678-813 N·m (500-600 ft-lb) using a piece of 7/8 inch hex-shaped case hardened metal stock or 7/8 Inch Hex Socket, Snap-On, IMA-283 or equivalent.



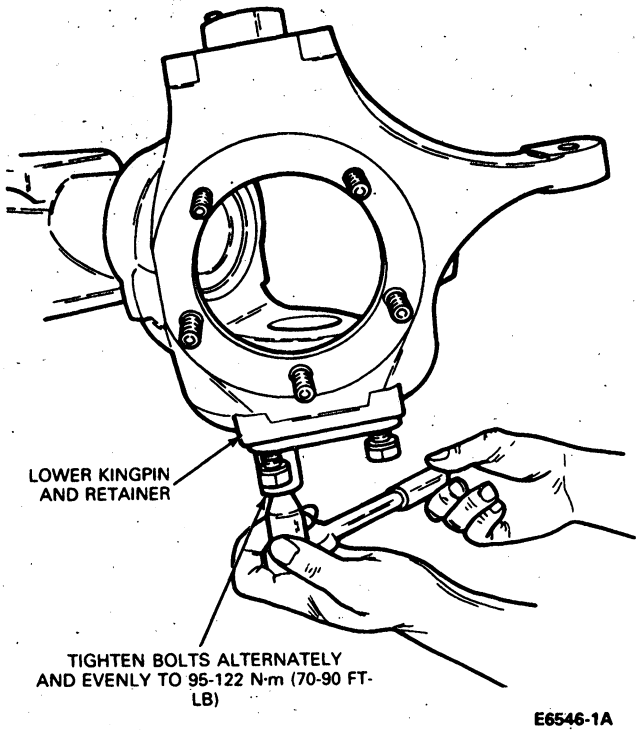
E6544-1A

7. Install the knuckle on the axle yoke.
8. Place the tapered bushing over the upper kingpin in the knuckle bore.



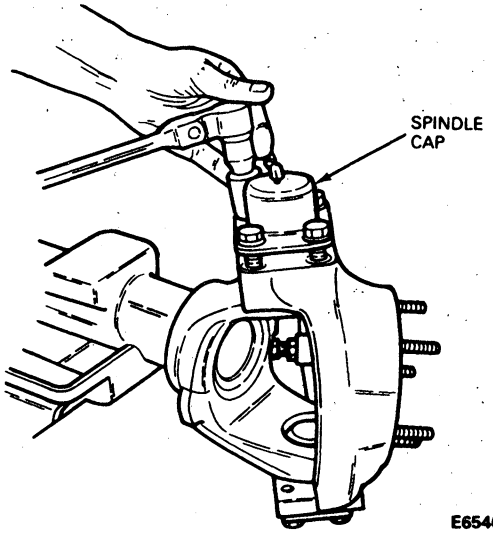
E6543-1A

9. Place the lower kingpin and retainer assembly in the knuckle and axle yoke. Install the four bolts and alternately and evenly tighten to 95-122 N·m (70-90 ft-lb).



E6546-1A

10. Place the retainer and compression spring on the tapered bushing.
11. Install a new gasket on the steering knuckle. Position the spindle cap on the gasket and knuckle. Install the four bolts, and alternately and evenly tighten to 95-122 N·m (70-90 ft-lb).

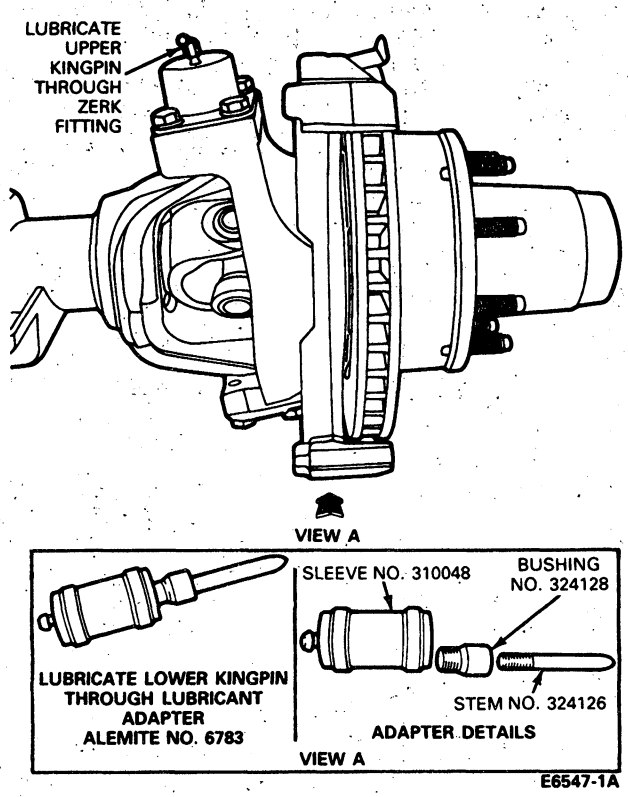


E6540-1A

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REMOVAL AND INSTALLATION (Continued)

12. Install the axle shaft as described under Axle Shaft in the Removal and Installation portion of this Section.
13. Lubricate the upper kingpin through the zerk fitting in the spindle cap with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
14. Lubricate the lower kingpin through the flush type fitting in the retainer with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Lubricate the flush type fitting using Lubricant Adapter, Alemite No. 6783 or equivalent.



Front Axle

Removal

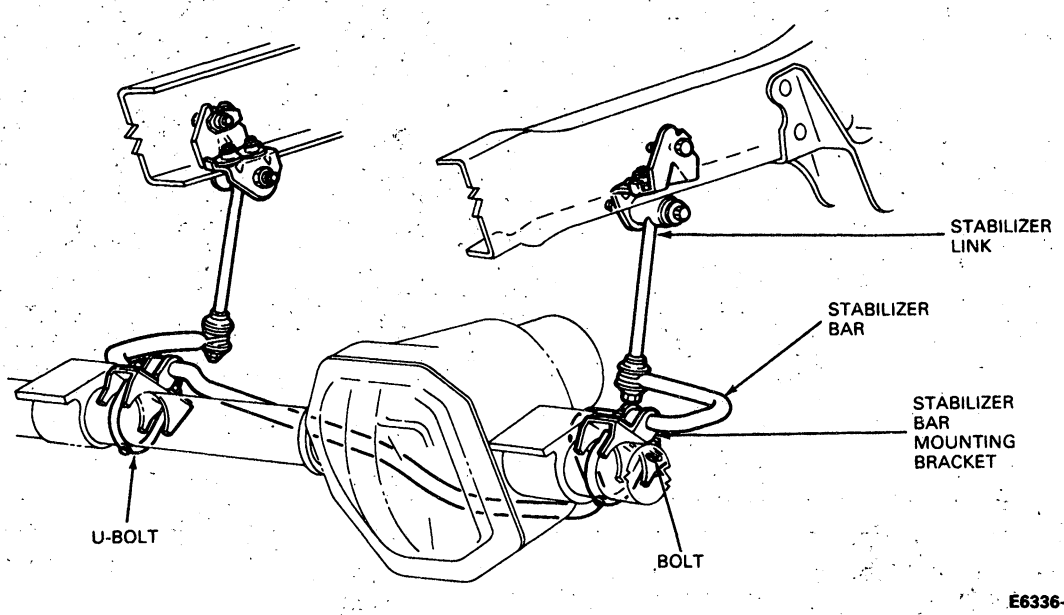
1. Raise the vehicle on a twin-post hoist.
2. Remove the front wheel and tire assemblies from the vehicle. Remove the hubs according to the procedures outlined in Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive. When removing hubs, use Hub Removal Tool D85T-1197-A or equivalent.
3. Remove the brake caliper from the rotor according to the procedures outlined in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

CAUTION: After removal, the brake caliper must be wired to the spring or otherwise supported to prevent suspending the caliper by the flexible hose. Allowing the caliper to hang by the flexible hose could result in brake line failure. If caliper suspension is not practical, remove it according to the procedures outlined in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

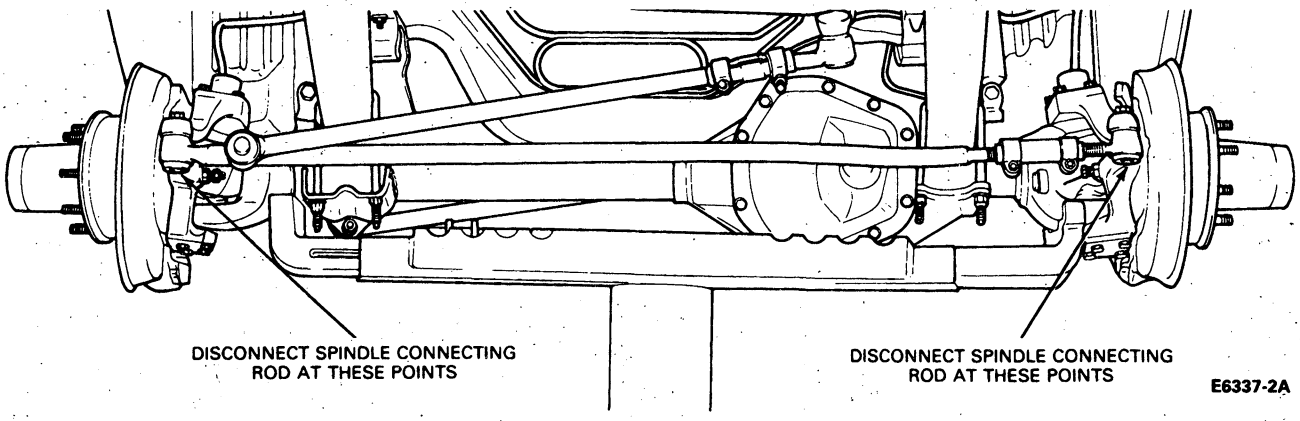
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REMOVAL AND INSTALLATION (Continued)

4. Remove the washers and nuts securing the stabilizer links to the stabilizer bar. Disconnect the stabilizer links from the stabilizer bar. If required, remove the U-bolts and bolts and nuts retaining the stabilizer bar and mounting brackets to the axle and remove the stabilizer bar.



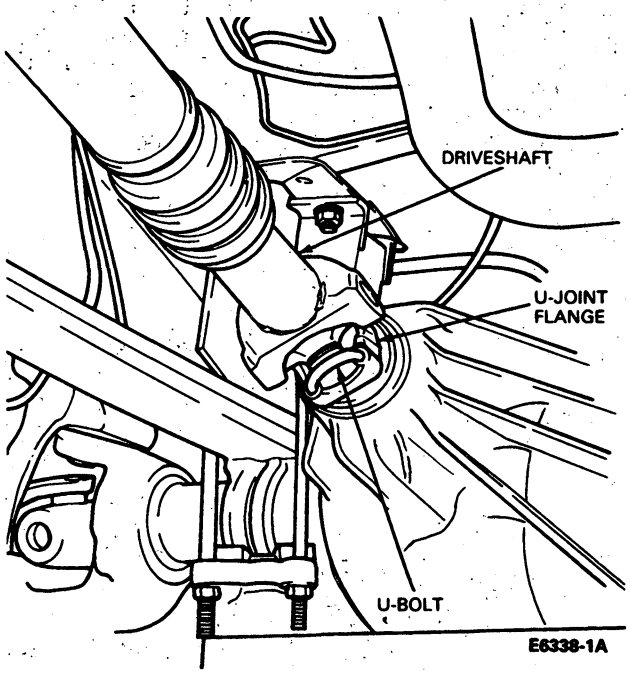
5. Remove the cotter pins and castellated nuts securing the spindle connecting rod to the steering knuckles. Separate the connecting rods from the steering knuckles using Pitman Arm Puller T64P-3590-F or equivalent. Wire the steering linkage to the spring.



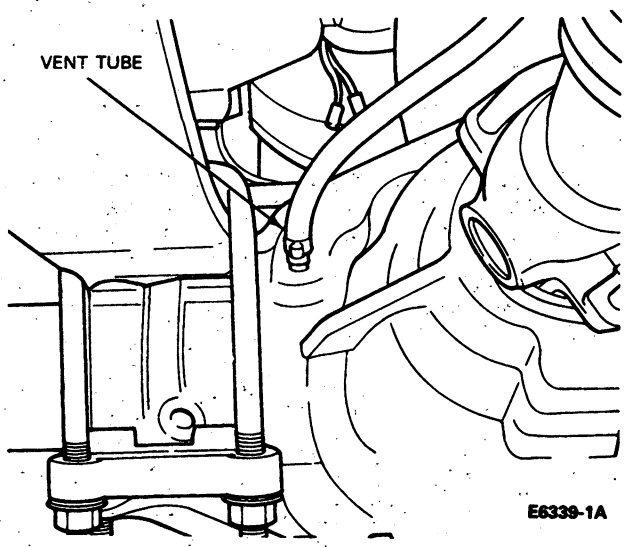
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REMOVAL AND INSTALLATION (Continued)

6. Remove the two nuts and U-bolts from the front axle U-joint flange and disconnect the axle from the front axle pinion flange. Securely wire the driveshaft to the frame.



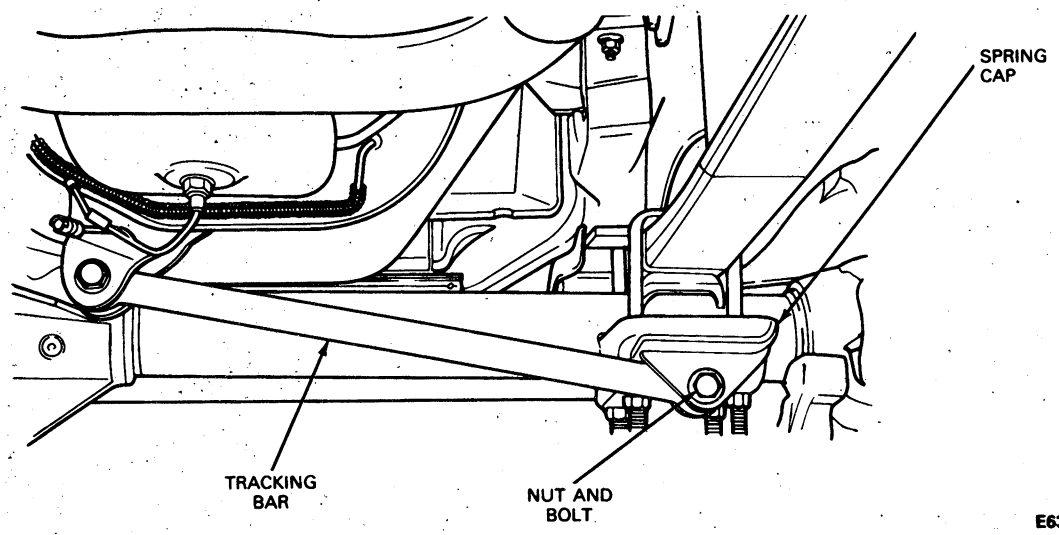
7. Disconnect the vent tube at the axle housing. Plug the vent fitting.



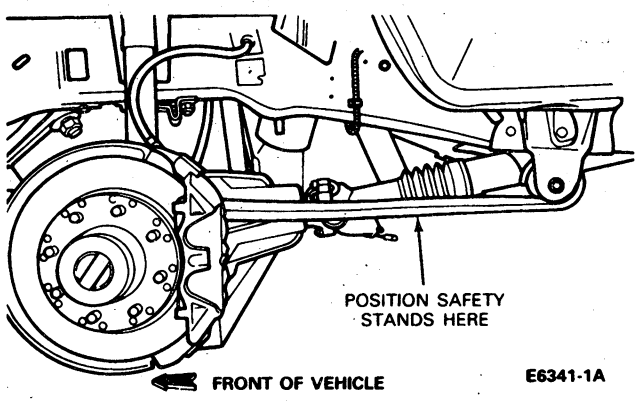
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REMOVAL AND INSTALLATION (Continued)

8. On the right-hand side of the vehicle, remove the nut and bolt and disconnect the tracking bar from the right-hand spring cap.

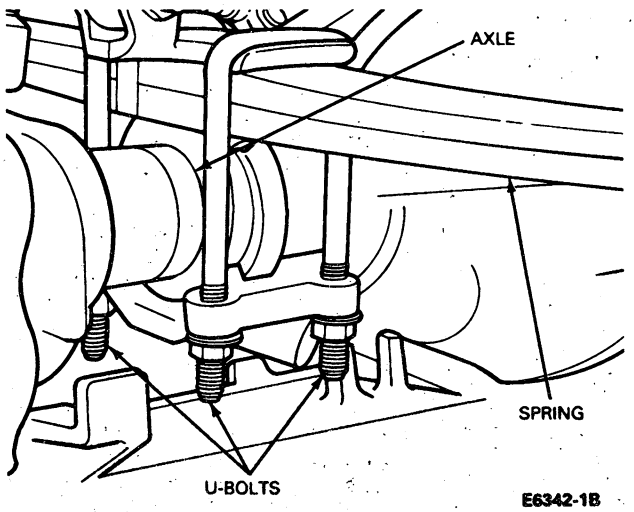


9. Carefully lower the twin-post hoist until the vehicle is approximately three feet from the floor. Position safety stands on the front leaf springs about halfway between the front axle leaf spring and the rear mounting shackle. Lower the vehicle so that the springs rest on the safety stands.



WARNING: BEFORE PROCEEDING, MAKE SURE THAT THE VEHICLE IS SECURELY SUPPORTED.

10. Support the axle under the differential carrier with a suitable jack, such as Rotunda Tool 077-00008 or equivalent.
11. Remove the U-bolts and nuts securing the axle to the spring.
12. Carefully lower the axle from the vehicle.
13. If required, place the axle in a differential carrier repair stand, such as Rotunda Tool 014-00257 or equivalent.

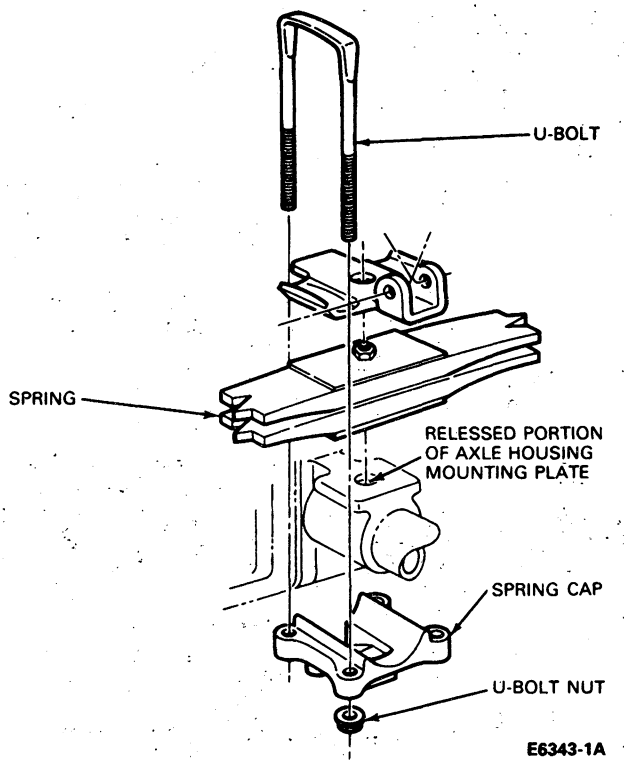


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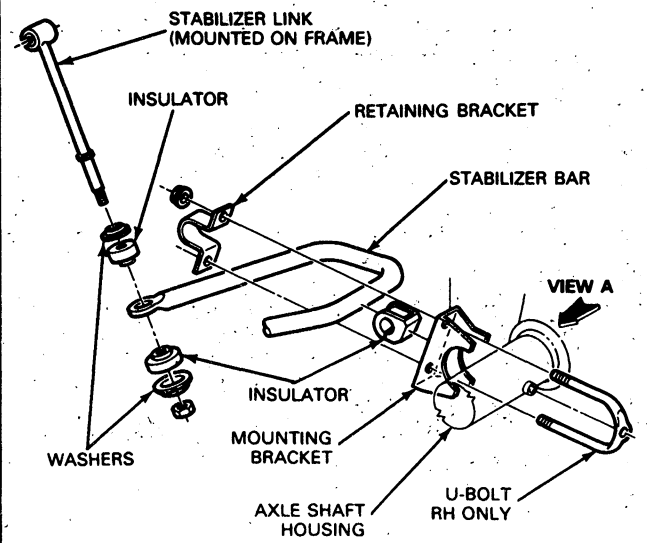
REMOVAL AND INSTALLATION (Continued)

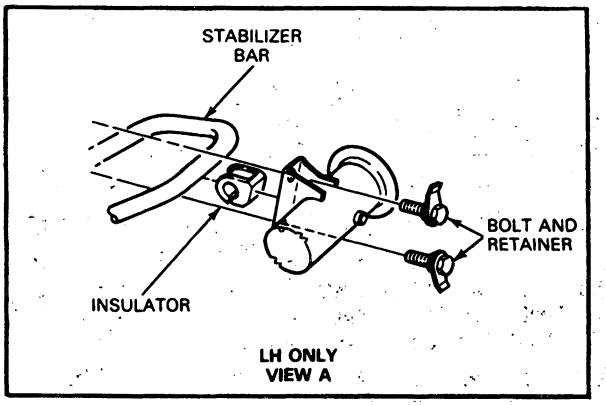
Installation

1. With the axle supported under the differential carrier by a suitable transmission jack, carefully raise the axle to the vehicle. Ensure that the retaining bolt head protruding from the leaf spring plate seats in the recessed portion of the axle spring mounting plate.
2. Install the nuts, U-bolts and spring caps securing the axle to the spring. Tighten to specifications listed at the end of this Section. Raise the vehicle to a suitable working height and remove safety stands.



3. Connect the driveshaft to the front axle pinion flange, secure with nuts and U-bolts and tighten to torque specifications listed at the end of this Section. For detailed instructions and procedures, see Section 15-60, Driveshafts—Single Type U-Joint.
4. On the right-hand side of the vehicle, connect the tracking bar to the spring cap, secure with nut and bolt and tighten to specifications listed at the end of this Section.
5. Connect the vent tube to the axle housing.
6. Connect the spindle connecting rods to the steering knuckles. Secure the connecting rod ends with castellated nuts and tighten to torque specifications listed at the end of this Section. Install cotter pins. (If necessary, advance nut to next castellation to install cotter pin.)
7. Connect stabilizer link to stabilizer bar. Tighten nuts and washers to specifications listed at the end of this Section. If removed, position stabilizer bar and mounting brackets on axle shaft housing and tighten to specifications listed at the end of this Section.
8. Install brake calipers and rotors as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
9. Install the hubs according to the procedures outlined in Section 11-12, Front Wheel Drive. Install the wheel and tire assemblies on the vehicle.
10. Lower the vehicle to the ground.





Drive Pinion Oil Seal

Removal

The drive pinion oil seal can be replaced without removing the axle assembly from the vehicle. Compounded or synthetic rubber seals do not require soaking.

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REMOVAL AND INSTALLATION (Continued)

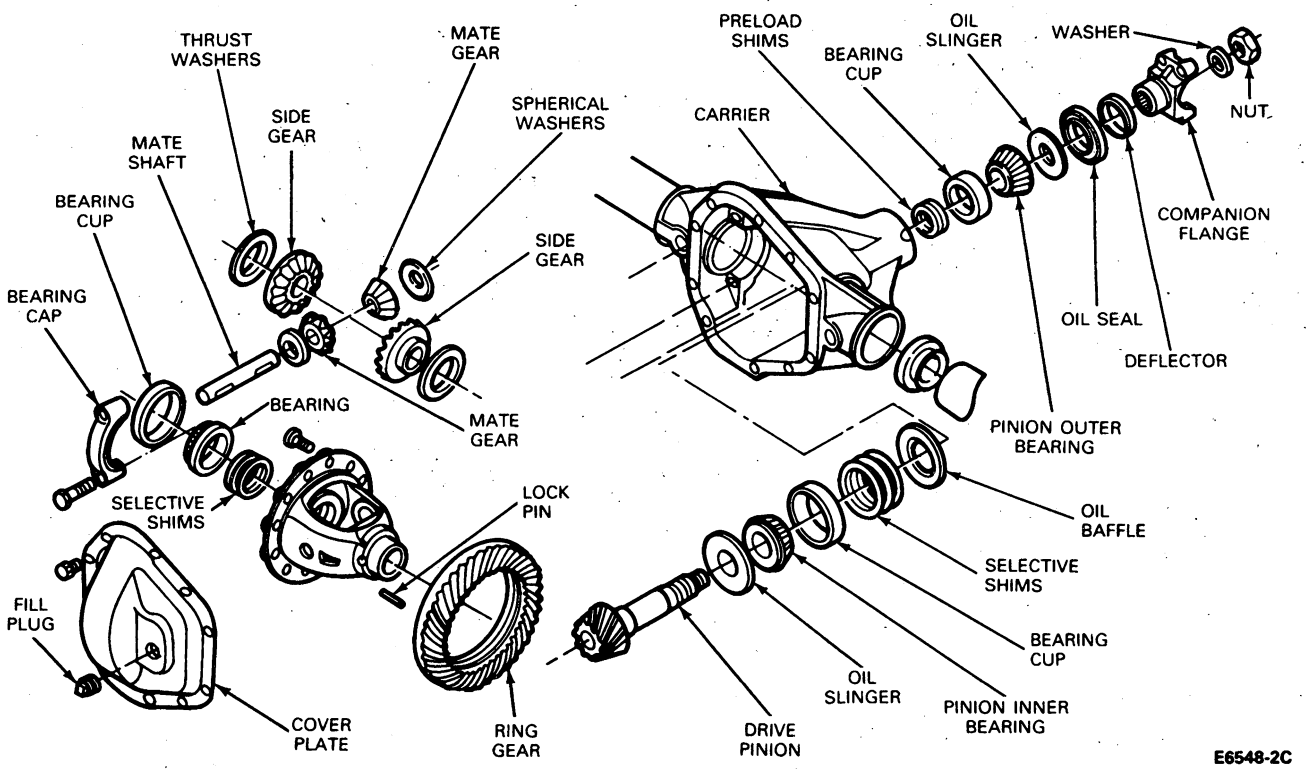
1. Raise the vehicle on a hoist or raise the front end of the vehicle with a jack. Install safety stands under the frame rails and lower the jack or hoist far enough to allow the axle to drop into the rebound position for working clearance.
2. Remove the nuts and two U-bolts from the front axle U-joint flange and disconnect the driveshaft from the front axle pinion flange. Wire the driveshaft to the frame.
3. Using Tool T57T-4851-B or equivalent to hold the pinion companion flange, remove the pinion shaft nut.
4. Using Tool T65L-4851-B or equivalent, remove the companion flange.
5. Using TOOL-1175-AC or equivalent, puller, in combination with slide hammer T50T-100A, remove the pinion oil seal.

Installation

1. Clean the pinion oil seal seat. Coat the sealing edge of the new seal with a small amount of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent. **Do not put sealer on the sealing lip.** Drive the seal into the housing, using Tool T83T-4676-A or equivalent.
2. Coat the inside of the pinion flange with a small quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent, and install the flange on the pinion shaft, using Tool-4858-E or equivalent.
3. Install the pinion attaching nut on the pinion shaft and tighten to torque specifications listed at the end of this Section.
4. Connect the driveshaft to the front axle pinion flange, secure with nuts and U-bolts and tighten to specifications listed at the end of this Section.
5. Raise the vehicle, remove the safety stands and then lower the vehicle to road position. Check the level of axle lubricant and add the specified lubricant as necessary.

DISASSEMBLY AND ASSEMBLY

Pinion, Drive Gear and Differential Case Carrier



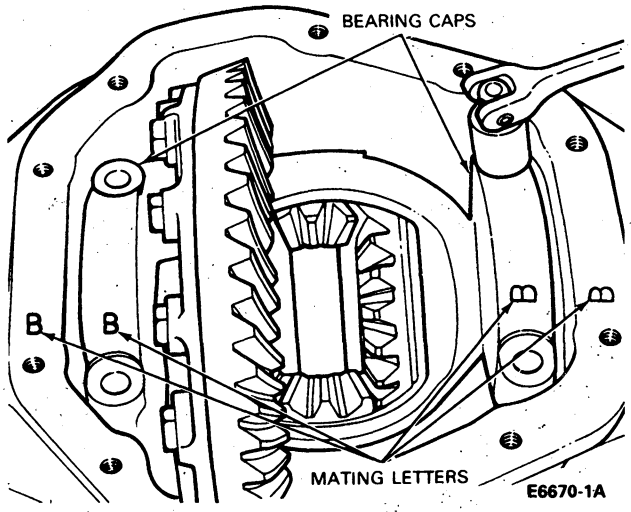
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DISASSEMBLY AND ASSEMBLY (Continued)

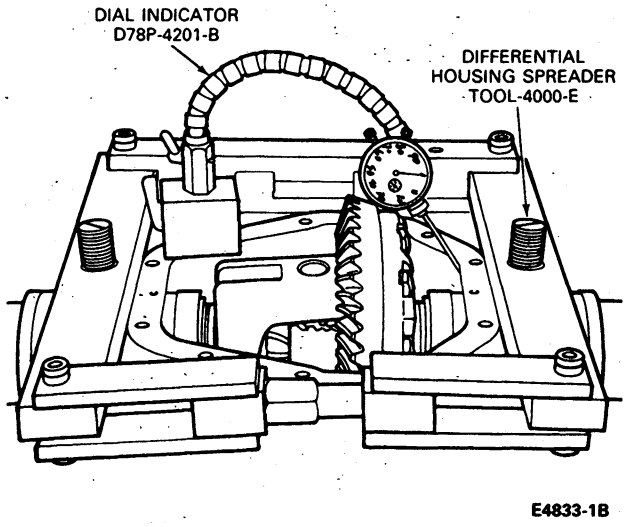
Disassembly

1. Remove the front axle from the vehicle as outlined in Removal and Installation—Front Axle in this Section.
2. Disconnect the steering linkage from the spindle. Remove the axle shafts as outlined in the Removal and Installation portion of this Section.
3. Position suitable container under differential carrier. Remove cover plate and drain lubricant from axle. The lubricant will drain out as the cover plate is removed. Tip carrier to allow lubricant to drain completely.
4. Remove any residual gasket material from carrier mating surface. Also clean cover face of carrier, making sure it is free of any nicks or burrs.
5. Loosen capscrews and remove bearing caps.

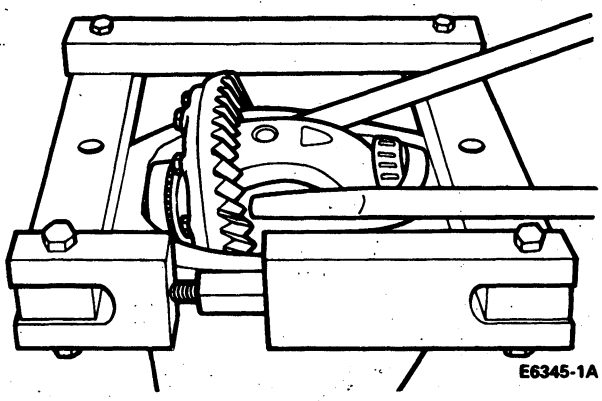
NOTE: Mating letters are stamped on bearing caps and carrier. This is important at time of assembly as they are to be assembled exactly as removed. Letters are in vertical and horizontal positions.



6. Place Differential Housing Spreader, Tool-4000-E or equivalent on the case. Install Dial Indicator, D78P-4201-B on the carrier housing. Do not spread housing more than 0.38mm (0.015 inch).



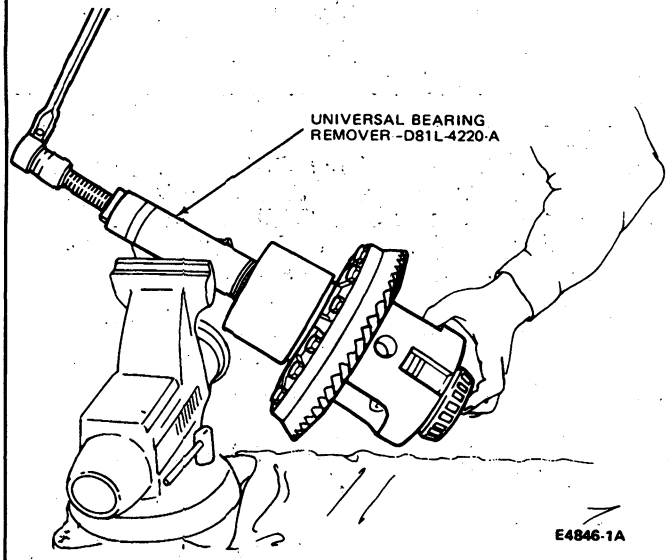
7. Pry differential case from carrier with two pry bars. After differential case has been removed, remove spreader. Use caution to avoid damage to ring and pinion. Mark or tag bearing cups for correct positioning during reassembly.



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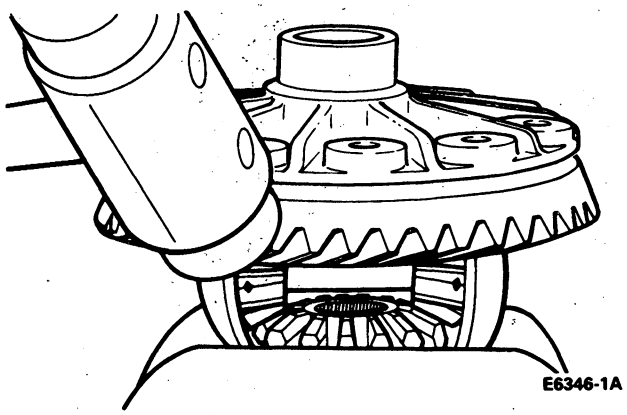
DISASSEMBLY AND ASSEMBLY (Continued)

8. Remove differential bearings with special tool, Universal Bearing Remover D81L-4220-A or equivalent. Place the tool in a vise when removing bearing. Wire shims, bearing cup and bearing cone together. Identify from which side they were removed. (Ring gear side or opposite side.) If shims are damaged, replace with new ones at time of assembly. Shims are available in thicknesses of 0.08, 0.13, 0.25, and 0.76mm (0.003, 0.005, 0.010, and 0.30 inch). Reposition case in puller and remove other bearing cone as described above. Replace bearings whenever they are removed from the carrier.

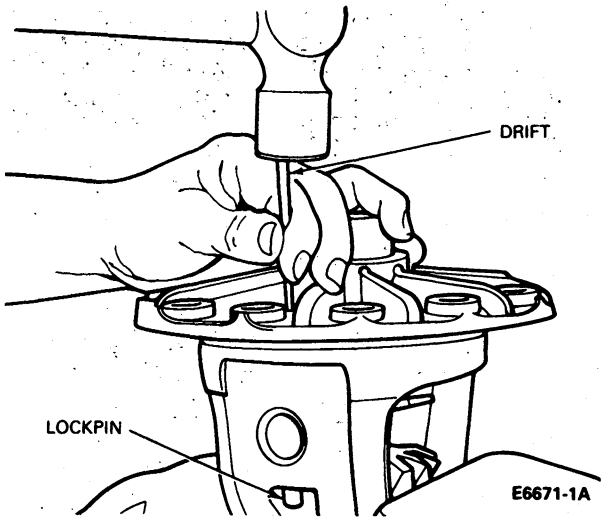


9. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked when it falls from the differential carrier. Place case in vise. Remove ring gear bolts. Tap ring gear with a rawhide hammer to free it from the case. Remove case and ring gear from vise.

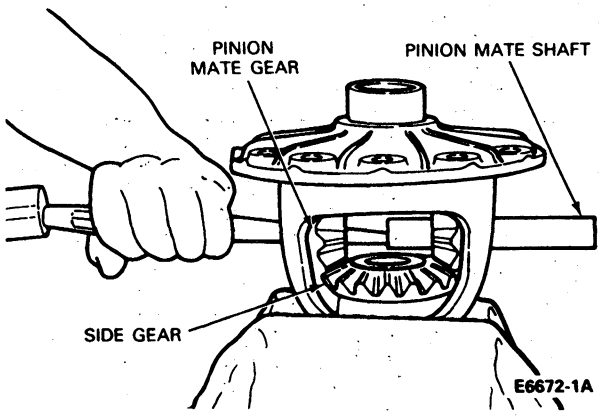
NOTE: Whenever removing the ring gear bolts, always replace with new bolts upon assembly.



10. Replace case in vise and use a small drift to drive out the lockpin that secures the pinion mate shaft.



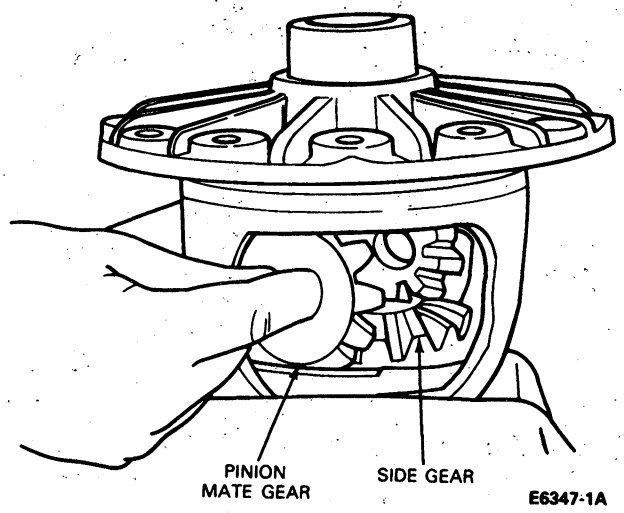
11. Remove pinion mate shaft with drift.



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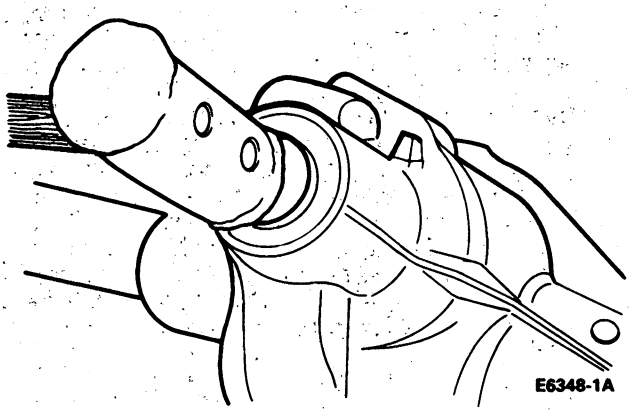
DISASSEMBLY AND ASSEMBLY (Continued)

12. To remove side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case. Remove pinion mate gears and also the spherical washers behind the gears. Lift out side gears and thrust washers. Inspect all parts, including the machined surfaces of the case itself. If excessive wear is visible on all parts, it is suggested that the complete differential assembly be replaced. If any one of the gears are to be replaced, THEY ARE TO BE REPLACED AS A SET.

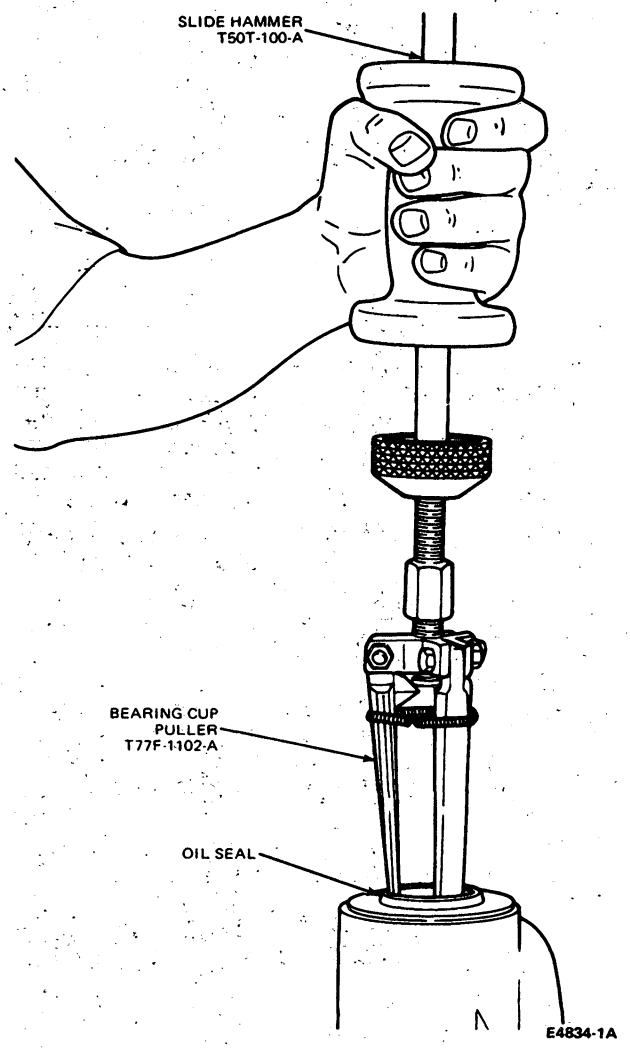


13. Turn nose of carrier in a horizontal position, remove pinion nut. Hold end yoke or flange with Tool T57T-4851-B (or equivalent) Companion Flange Holding Tool, and remove pinion nut and washer.
14. Remove end yoke or flange with T65L-4851-B or equivalent, Yoke Remover. If end yoke or flange shows wear in the area of the seal contact, it should be replaced.
15. Remove pinion by tapping with a rawhide hammer. Catch the pinion with your hand to prevent it from falling to the ground and being damaged.

NOTE: On the spline end of the pinion, there are bearing preload shims. These shims may stick to the pinion or bearing or even fall out. These shims are to be collected and kept together since they will be used later in assembly. Try not to damage shims. If shims are damaged, replace with new ones. Shims are available in thicknesses of 0.08, 0.13, 0.25, and 0.76mm (0.003, 0.005, 0.010, and 0.030 inch).



16. Pull out pinion seal with Puller T77F-1102-A, Bearing Cup Puller and T50T-100-A, Slide Hammer. Discard seal. REPLACE WITH NEW ONE AT TIME OF ASSEMBLY. Remove bearing cone and outer oil slinger.



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DISASSEMBLY AND ASSEMBLY (Continued)

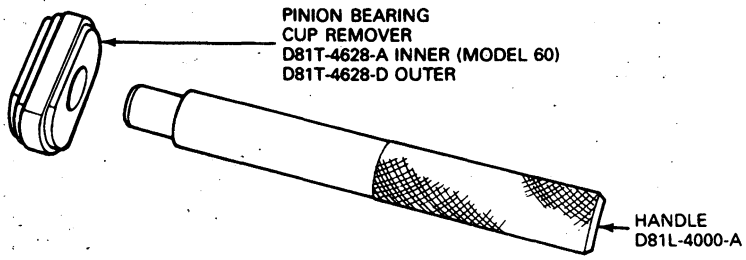
17. Turn nose of carrier down. Remove outer pinion bearing cup with Bearing Cup Remover D81T-4628-D and Driver Handle D81L-4000-A or their equivalents. Locate driver on back edge of cup; drive cup out of carrier.

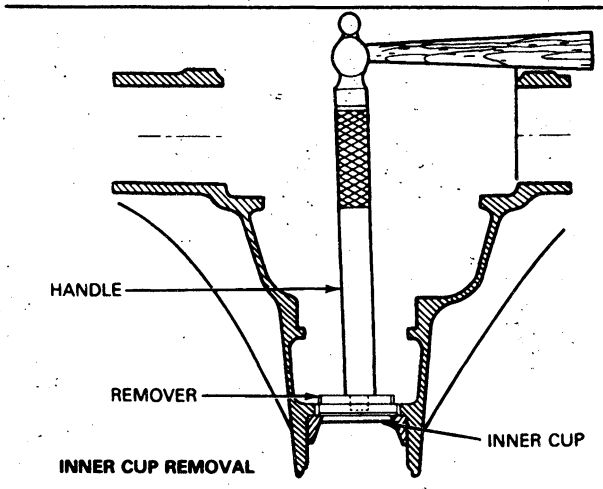
CAUTION: Do not nick carrier bore.

NOTE: The front carrier section may vary in pinion bore depth due to the possibility of the need for either a baffle or slinger or both.

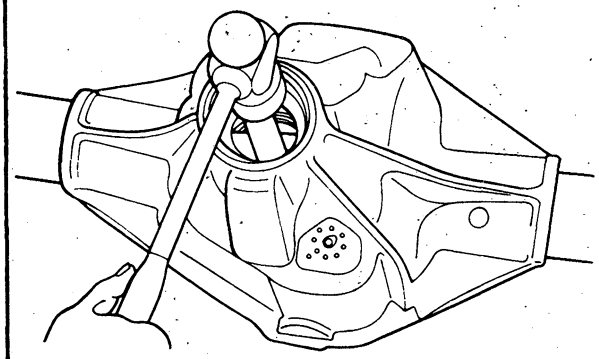
18. Remove the inner bearing cup with Bearing Cup Remover, D81T-4628-A and Driver Handle D81L-4000-A or equivalents.

NOTE: Shims are located between the bearing cup and carrier bore and may also include an oil baffle. If shims and baffles are bent or nicked, they should be replaced at time of assembly. Wire shim stacks together and measure each. If stack has to be replaced, replace with same thickness.





INNER CUP REMOVAL



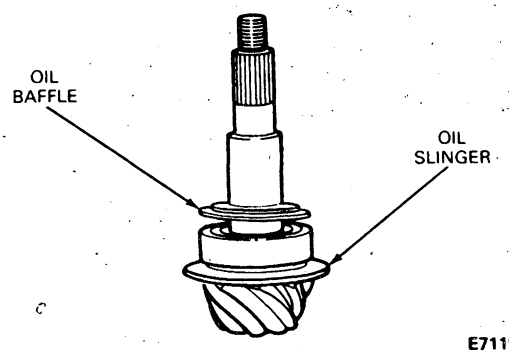
OUTER CUP REMOVAL

E6349-2A

NOTE: Both baffle and slinger are part of the pinion adjustment shims and are to be kept intact for assembly.

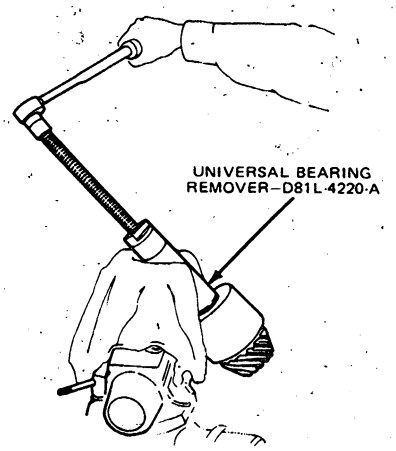
The baffle serves the same purpose as a dam, to assure that the pinion bearings are maintained with lubricant.

The slinger serves the purpose of assisting the lubricant to flow up through the oil channels to lubricate the pinion bearings. If used, they are part of the pinion setting adjustment.



E7115-1A

19. Remove bearing from pinion with Universal Bearing Remover, D81L-4220-A or equivalent. Bend the slinger as required to obtain clearance for remover tool installation. Discard the slinger.



E4847-1A

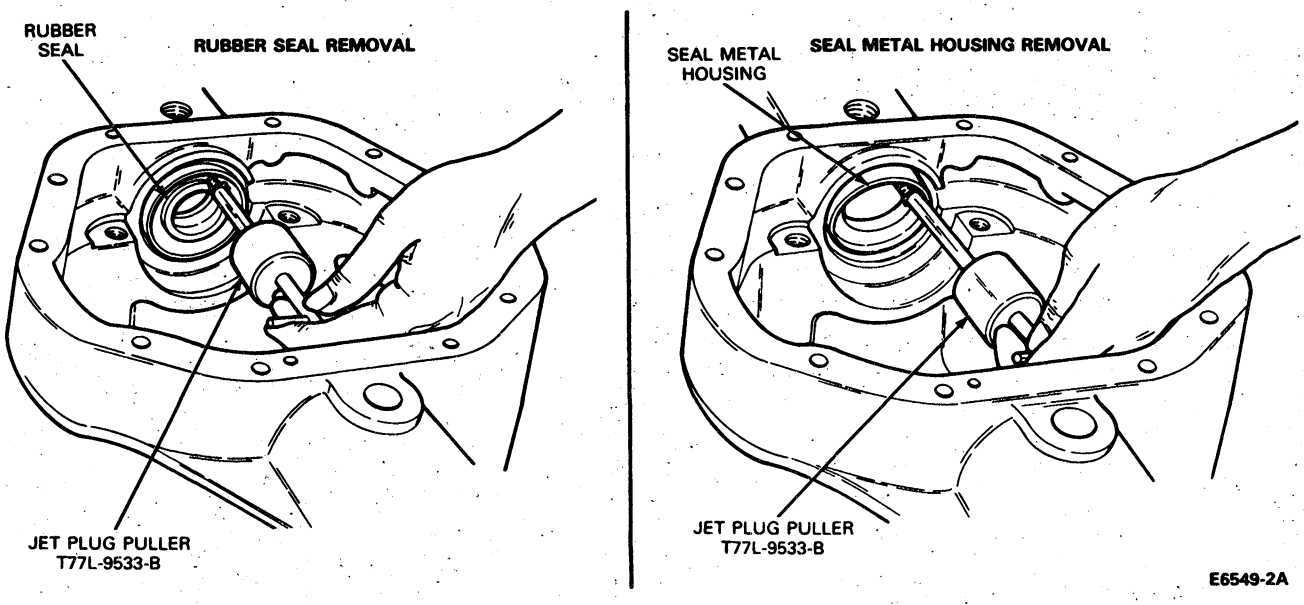
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DISASSEMBLY AND ASSEMBLY (Continued)

20. If required, remove the inner axle shaft seals with Jet Plug Remover, T77L-9533-B or equivalent. Thread the remover tool into the rubber seal and remove and discard the seal. Thread the remover tool into the metallic seal housing and remove and discard the seal housing.

NOTE: The inner axle shaft seal is serviced as a two-piece, rubber seal and metallic housing assembly.

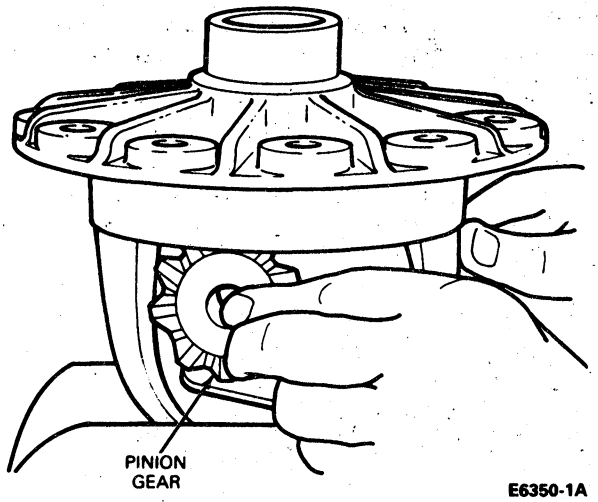
INNER AXLE SHAFT SEAL REMOVAL



Differential Case

Assembly

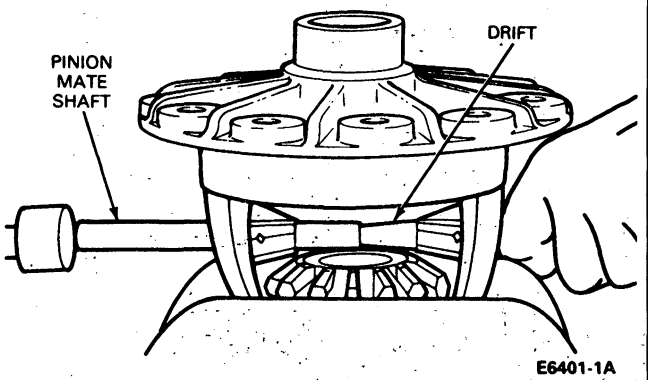
1. Place differential case in vise. Apply grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, to new side gear thrust washers and to hubs and thrust face of the new side gears. Assemble both side gears. Apply grease to the new spherical washers, and the new pinion mate gears. Assemble new pinion mate gears and washers.
2. Assemble both side gears and thrust washers, hold in place with hand, then assemble the pinion mate gears and washers to hold the side gears in place. An easy way to assemble the side gears and pinion mate gears is to have all parts lubricated before assembly.
3. Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shaft.



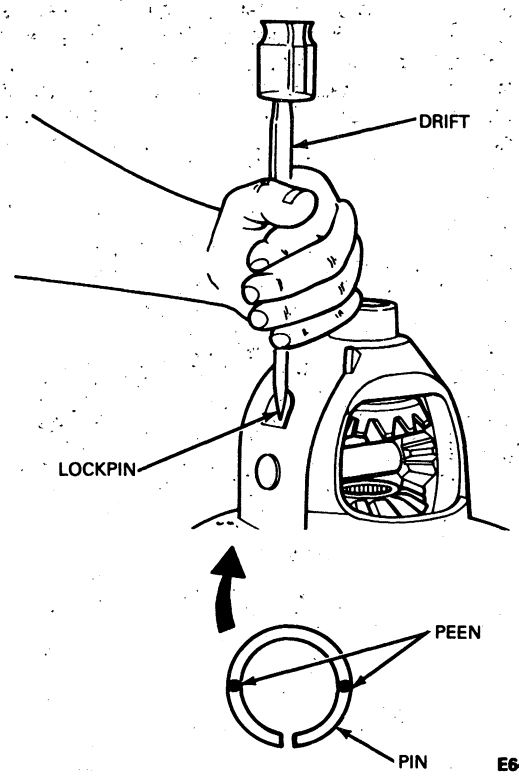
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DISASSEMBLY AND ASSEMBLY (Continued)

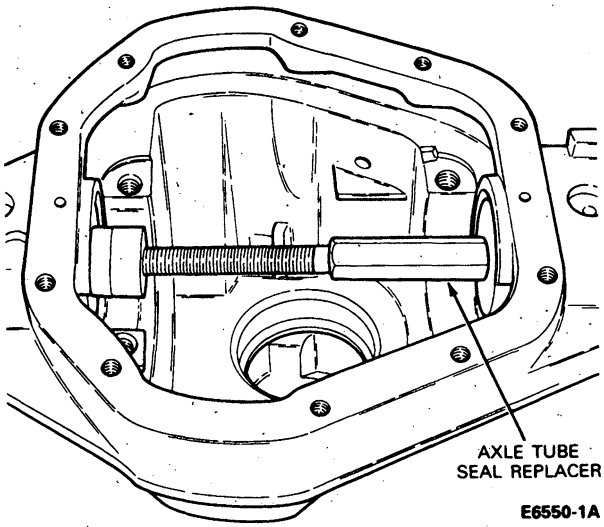
4. Use a drift to line up the holes with those of the differential case.
5. Assemble pinion mate shaft, drive on shaft to remove drift. Be sure lockpin hole of the shaft is lined up with the lockpin hole of the case.



6. Assemble lockpin (roll pin). Peen metal of case over pin to lock in two places 180 degrees apart.



7. Be sure flange face of the case is free of nicks or burrs. Assemble ring gear to case. Line up holes of the ring gear with those of the case. Use new ring gear bolts. Draw up bolts alternately and evenly. Tighten ring gear bolts to 136-163 N·m (100-120 ft-lb).
8. Place the inner axle seals in the axle tube housing. Press both seals in at the same time with an appropriate installation tool. Make sure the seals are pressed in straight and not cocked in the bore. Coat the lips of the seals with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
9. Install Master Differential Bearings, Tool D81T-4222-D or equivalent onto case. Remove all nicks, burrs, dirt, etc., from hubs to allow bearings to rotate freely.

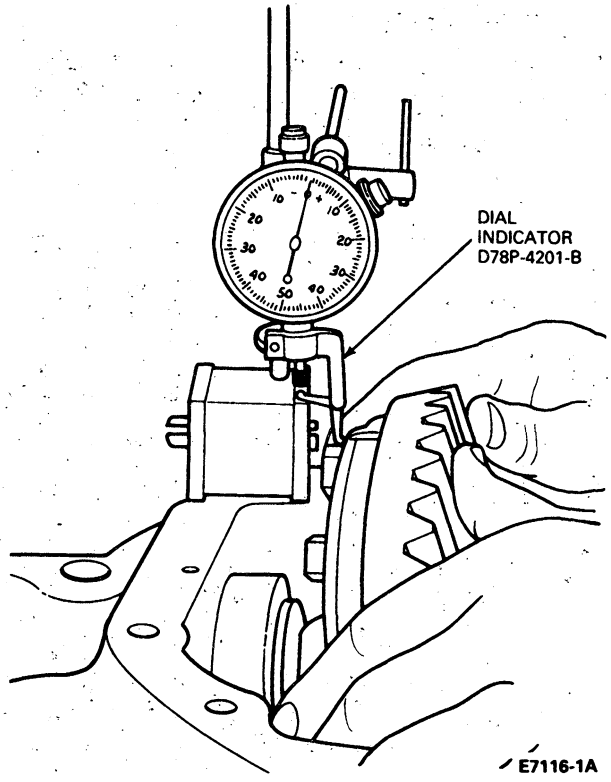


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DISASSEMBLY AND ASSEMBLY (Continued)

10. Assemble differential case into carrier (less pinion). Mount Dial Indicator D78P-4201-B or equivalent with a magnetic base as shown. Locate tip of indicator on flat surface of one of the ring gear bolt spot faces. Force differential assembly as far as possible in the direction towards the indicator. With force still applied, set indicator at zero.

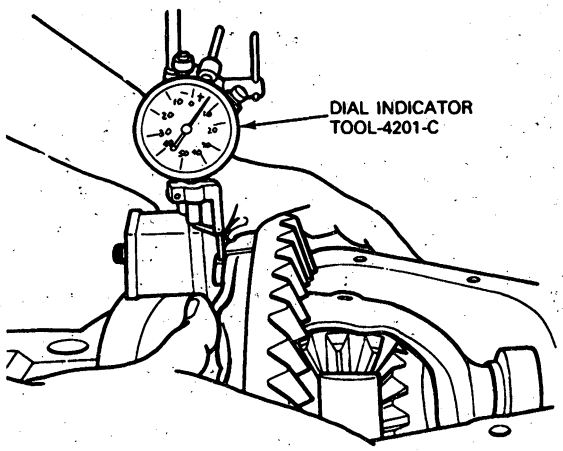
NOTE: Dial indicator should have a minimum travel capability of 5.08mm (0.200 inch).



E7116-1A

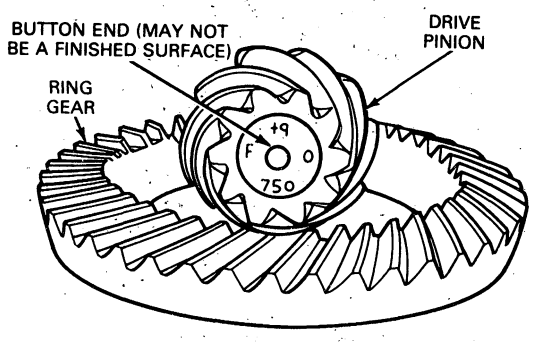
11. Force the differential assembly as far as it will go in the opposite direction. Repeat these steps until you have obtained the same reading. Record the reading of the indicator. This will be the total amount of shims required (less preload) and will be calculated later during assembly. After making sure the readings are correct, remove indicator and differential assembly from housing. DO NOT REMOVE MASTER BEARINGS FROM DIFFERENTIAL CASE AT THIS TIME.

This reading is the total differential case end play which will be needed in Step 6 of Assembly of Differential into Housing in this Section.



E6403-1B

12. Ring gears and pinions are supplied in matched sets only. Matching numbers on both the pinion and ring gear are etched for verification. If a new gearset is being used, verify the numbers of each pinion and ring gear before proceeding with assembly.



STANDARD PINION

E7117-1B

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DISASSEMBLY AND ASSEMBLY (Continued)

The distance from the centerline of the ring gear to the backface of the pinion (Model 60) is 127mm (5.000 inch).

On the backface of each pinion, there is etched a plus (+) number, a minus (-) number, or a zero (0) number which indicates the best running position for each particular gearset. This dimension is controlled by the shimming behind the inner pinion bearing cup.

NOTE: Do not use the backface of the pinion for pinion positioning. The backface of the pinion is no longer a ground surface.

For example—If a pinion is etched a plus m+8 (+3), this pinion would require 0.08mm (0.003 inch) less shims than a pinion etched "0". This means by removing shims, the mounting distance of the pinion is increased, which is just what m+8 (+3) indicates. Or if a pinion is etched m-8 (-3), we would want to add 0.08mm (0.003 inch) more shims than would be required if the pinion were etched "0". By adding 0.08mm (0.003 inch) shims, the mounting distance of the pinion was decreased, which is just what m-8 (-3) indicated.

If the old ring and pinion set is to be reused, measure the old shim pack and build a new shim pack to this same dimension. If a baffle is used in the axle assembly, it is considered as part of the shim pack.

To change the pinion adjustment, shims are available in thicknesses of 0.08, 0.13, and 0.25mm, (0.003, 0.005, and 0.010 inch).

NOTE: If baffle or slinger is bent or mutilated, it should be replaced.

Measure each shim separately with a micrometer and add together to get the total shim pack thickness from the original buildup.

If a new gearset is being used, notice the (+) or (-) etching on both the old and new pinion and adjust the thickness of the new shim pack to compensate for the difference of these two figures.

For example—If the old pinion reads m+5 (+2) and the new pinion is m-5 (-2), add 0.10mm (0.004 inch) shims to the original shim pack.

PINION SETTING CHART — METRIC

Old Pinion Marking	New Pinion Marking								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

CE6651-2A

PINION SETTING CHART — ENGLISH

Old Pinion Marking	New Pinion Marking								
	−10	−8	−5	−3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+ 8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03
+ 5	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05
+ 3	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08
0	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10
− 3	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13
− 5	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15
− 8	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18
−10	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18	−.20

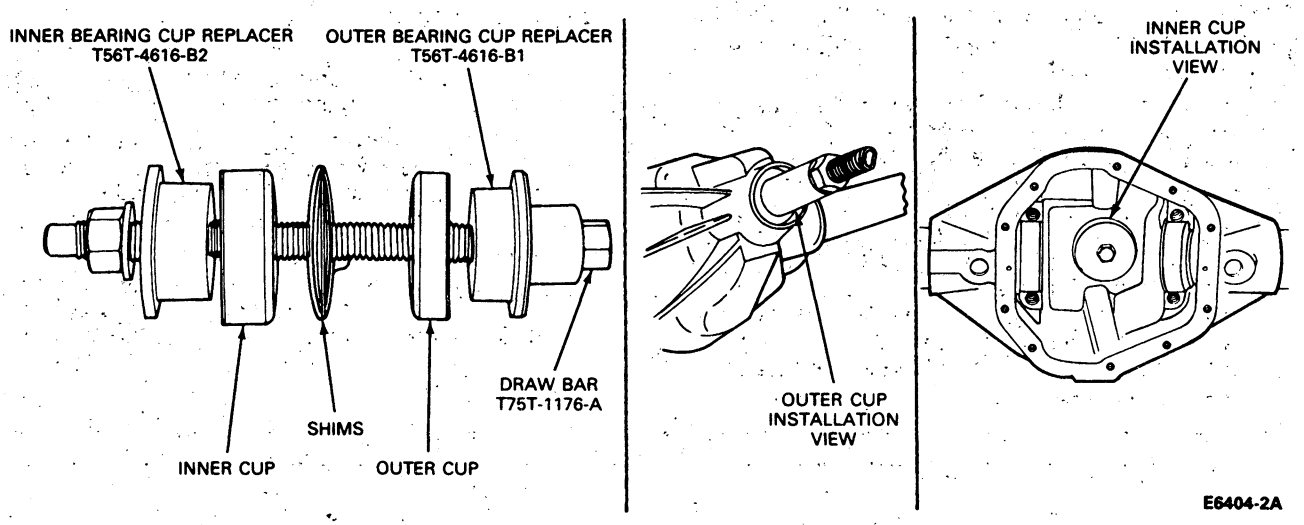
CE6652-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

Pinion Bearing Cup Installation

1. Place the preload shims under the inner cup as shown.
2. Place the inner and outer bearing cups into the carrier bore.
3. Place the Inner Bearing Cup Replacer Tool T56T-4616-B2 or equivalent on the inner bearing cup.
4. Place the Outer Bearing Cup Replacer Tool T56T-4616-B1 or equivalent on the outer bearing cup.
5. Install the Threaded Drawbar, T75T-1176-A or equivalent, into the replacer tools and tighten the drawbar to install the cups into the carrier bore.

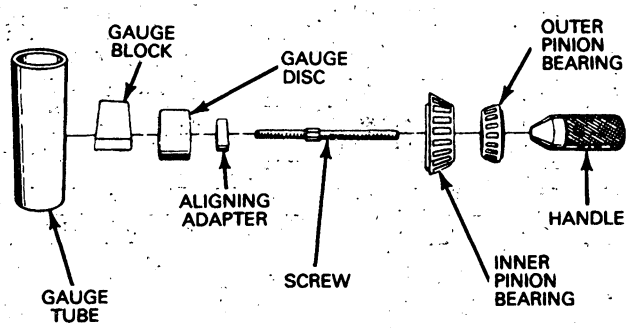


Depth Gauge Check

1. Refer to the chart below for the correct tools for the particular axles.

NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure correct readings.

2. Place a new inner pinion bearing over the proper aligning adapter and insert into the pinion bearing retainer assembly. Place the outer pinion bearing (new or used if in good condition) into the bearing cup and assemble the handle onto the screw and hand tighten. Note the 3/8 inch square drive in the handle to be used for obtaining the proper pinion bearing preload. Tighten to preload of 2.26-4.53 N·m (20-40 in-lb).
3. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten capscrews to 109-147 N·m (80-90 ft-lb).
4. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge directly along the gauge block to insure a correct reading. The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling. Make sure the shims or feeler gauges are free of dirt to ensure a correct reading.



Description	Number
Handle	T76P-4020-A11
Screw	T80T-4020-F43
Gauge Block	T80T-4020-F42
Aligning Adapter	T76P-4020-A3
Gauge Disc	T78P-4020-A15
Gauge Tube	D80T-4020-F48

CE6653-1B

5. After the correct feeler gauge feel is obtained, check the reading. This is the thickness of shim(s) required providing that, upon inspection of the service pinion gear, there are no markings.

NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in Step 4.

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DISASSEMBLY AND ASSEMBLY (Continued)

If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in Step 4.

In addition, you must use the exact same new inner pinion bearing that was used in the previous steps.

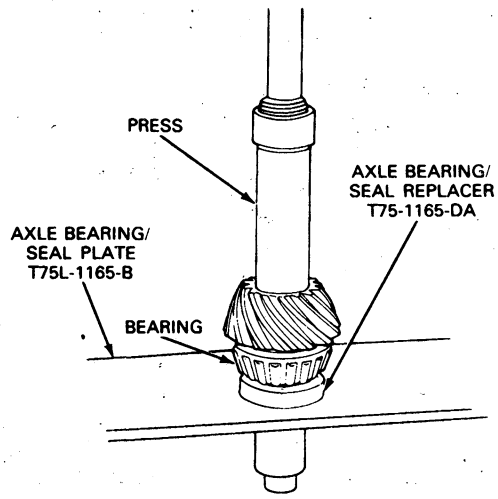
6. Remove the inner pinion bearing cup and install the correct thickness of shims in the carrier bore. Re-install the bearing cup and oil slinger (if used) on the pinion and press on the bearing with T53T-4621-C or equivalent.

NOTE: If a baffle or slinger is used, replace with a new one upon assembly and measure as part of the shim stack.

7. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

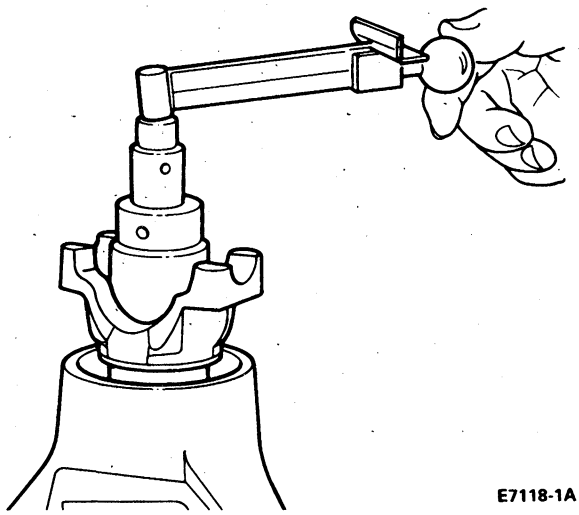
Pinion Bearing Preload and Final Depth Check

1. Assemble preload shims and slinger (if used) onto pinion. Assemble bearing cone. Using T75L-1165-B, Axle Bearing/Seal Plate and T75L-1165-DA, Axle Bearing/Seal Replacer or their equivalents.



E6405-1A

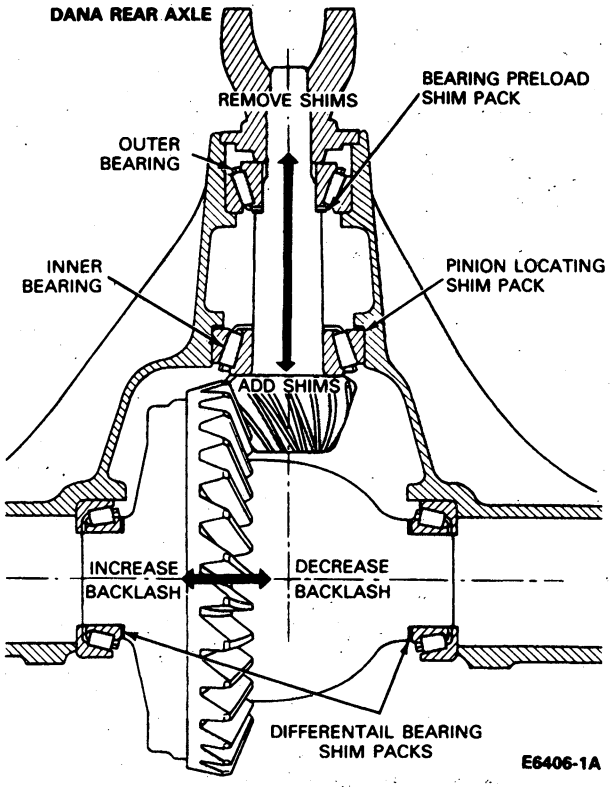
2. Assemble end yoke, washer and new pinion nut. Tighten nut to torque specifications listed at the end of this Section.
3. Using an inch-pound torque wrench, rotate pinion. The torque required to rotate the pinion should be between 2.26-4.53 N·m (20-40 in-lb). To increase preload, remove shims from drive pinion. To decrease preload, add shims to pinion.


E7118-1A

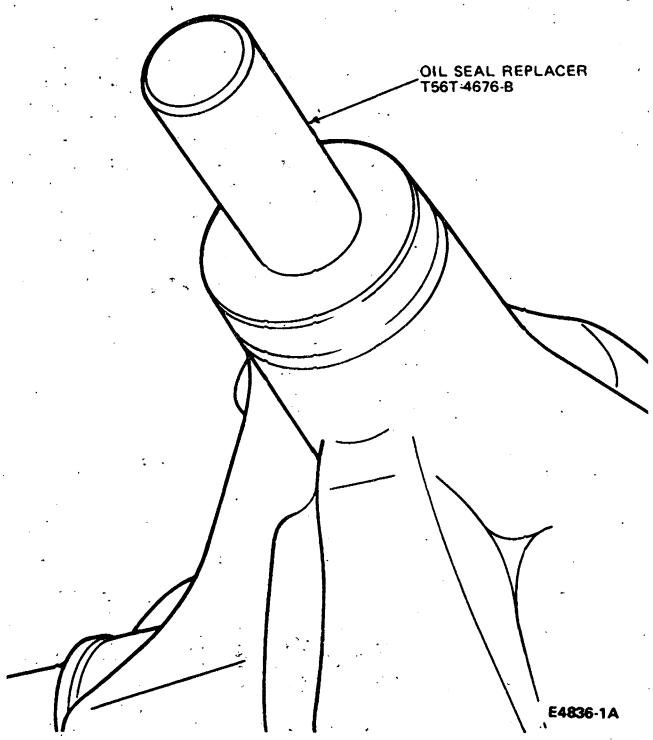
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DISASSEMBLY AND ASSEMBLY (Continued)

The illustration shows the arrow in the pinion pointing in two directions. The arrow pointing towards the end yoke indicates that by removing pinion position shims, the distance from the centerline of the axle to the pinion button is increased giving a plus reading. The arrow pointing toward the drive pinion indicates that by adding pinion shims, the distance from the centerline of the axle to the pinion button is decreased, giving a minus reading. The pinion bearing preload shim pack does not affect the pinion depth setting. The arrows on the ring gear show the method for increasing or decreasing ring gear backlash by inserting or removing differential bearing shims.



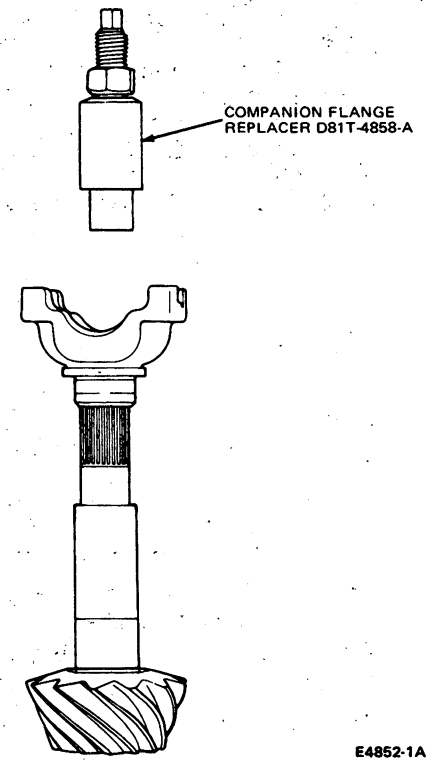
4. With the drive pinion at the correct depth, remove the yoke with Holding Tool, T78P-4851-A and Yoke Remover, T65L-4851-B or equivalents. Remove the yoke, nut and washer.
5. Coat the oil seal with grease. Install the drive pinion oil seal with Oil Seal Replacer, T56T-4676-B or equivalent. After installation, make sure the garter spring did not pop out. If the garter spring pops out, remove and replace seal.



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DISASSEMBLY AND ASSEMBLY (Continued)

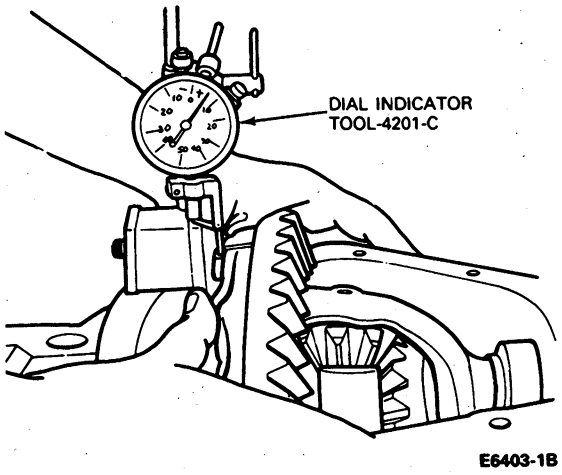
6. Install the yoke with Companion Flange Replacer, D81T-4858-A or equivalent, if necessary to draw the drive pinion up to engage the nut. Install the washer and nut and tighten nut to torque specifications listed at the end of this Section.



Assembly of Differential Into Housing

Ring Gear and Pinion Backlash

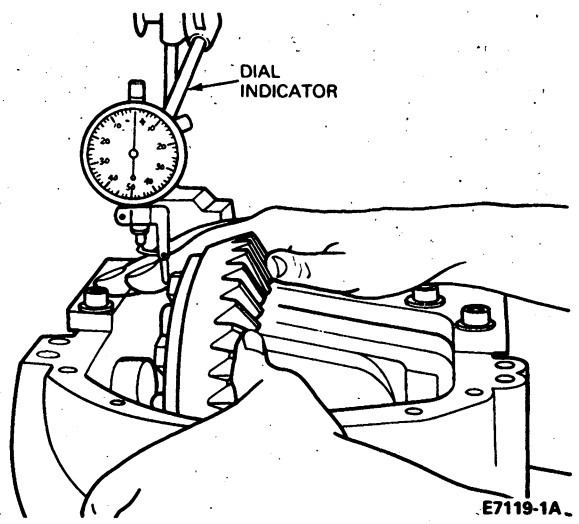
1. Place differential assembly (with pinion installed) into housing. Differential master bearings should still be assembled to case.
2. Set up dial indicator Tool 4201-C or equivalent. Force ring gear into mesh with the pinion. Rock ring gear to allow the teeth of the gears to mesh. With force still applied to the differential case, set indicator at zero.



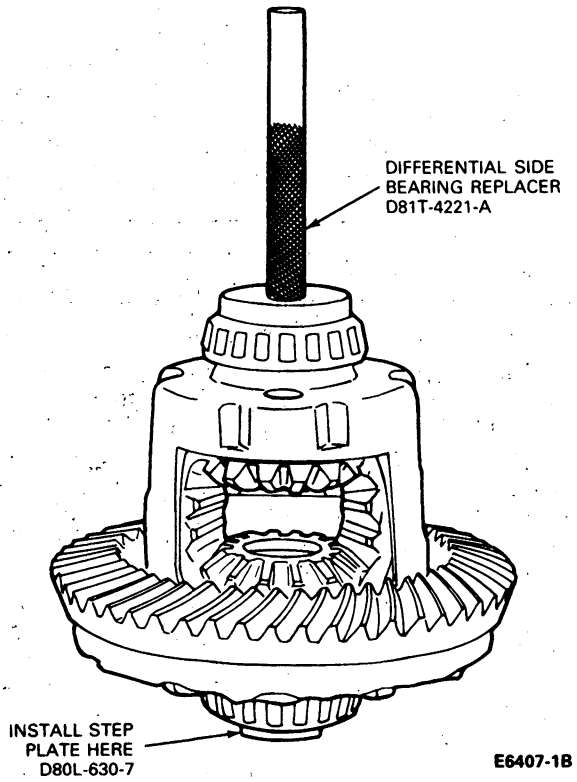
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DISASSEMBLY AND ASSEMBLY (Continued)

3. Force the differential case (ring gear) away from the pinion gear to obtain an indicator reading. Repeat until the same reading is obtained each time. This reading will be the necessary amount of shims required between the differential case and differential bearings on the ring gear side. Remove indicator and differential case from the carrier. Remove master bearings from differential case.



4. As determined in Step 3, place the required amount of shims on the ring gear hub of the differential case. For example: if the reading in Step 3 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.
5. Install the bearing cone on the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer, D81T-4221-A or equivalent as shown.



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DISASSEMBLY AND ASSEMBLY (Continued)

6. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in Step 3 from the total differential case end play. Total case end play was determined under Steps 9 and 10 of Differential Case—Assembly. When this amount is determined, add 0.36mm (0.015 inch) to the amount. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

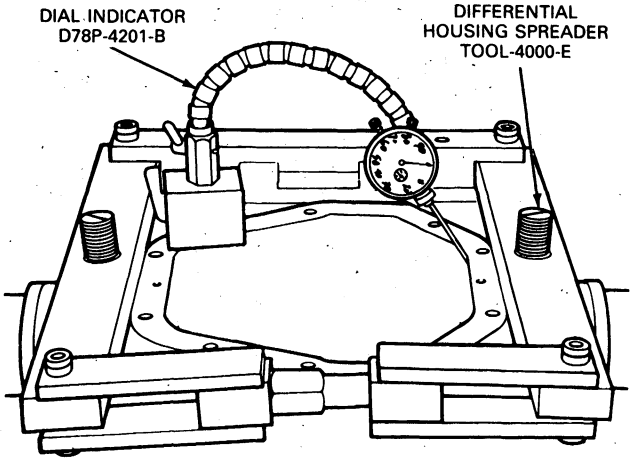
   For example: Total Differential Case End Play was 2.30mm (0.091 inch). The reading in Step 3 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch). 0.36mm (0.015 inch) is added to give 1.52mm (0.061 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.

7. Place the required amount of shims on the hub of the drive pinion side of the differential case.

8. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate D80L-630-7 or equivalent for Model 60 axles on the ring gear side bearing to protect the bearing during installation of the drive pinion side bearing. Place the bearing on the drive pinion side hub and drive it on using Differential Side Bearing Replacer, D81T-4221-A or equivalent.

9. Install spreader and indicator to carrier. Remove indicator.

CAUTION: Do not spread carrier over 0.38mm (0.015 inch).

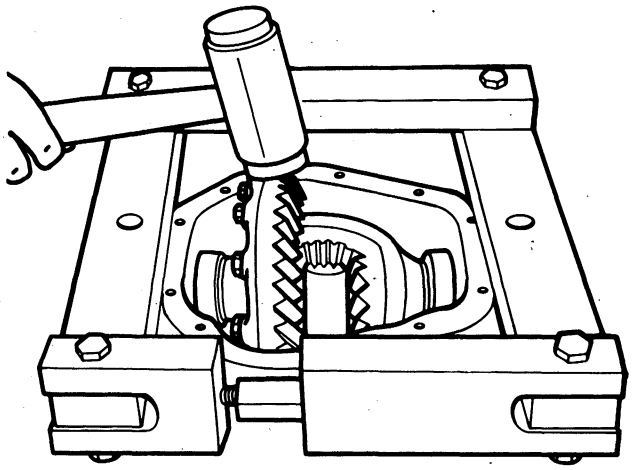


E8074-1A

10. Assemble differential bearing cups to differential bearing cones.

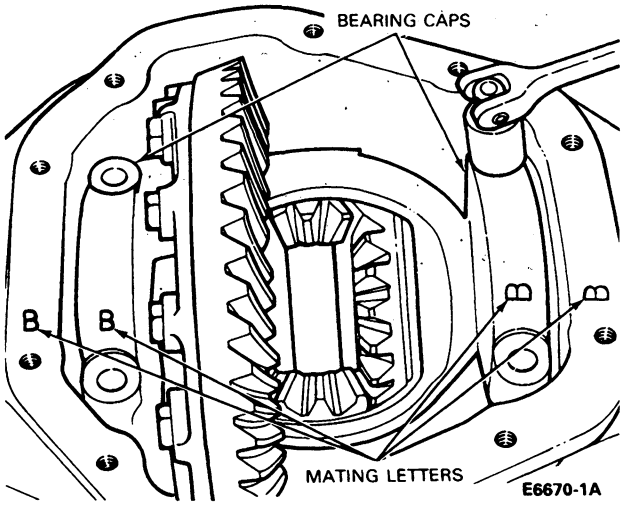
    Install differential assembly into carrier.

    Use a rawhide hammer to seat differential assembly into crossbore of carrier. Care should be taken to avoid nicking the teeth of the ring gear and pinion during assembly. Remove the spreader from the differential case.



E8018-1A

11. Install bearing caps. Make sure the letters stamped on the caps correspond with those on the carriers. Tighten bearing cap screws to torque specifications listed at the end of this Section.



E6670-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

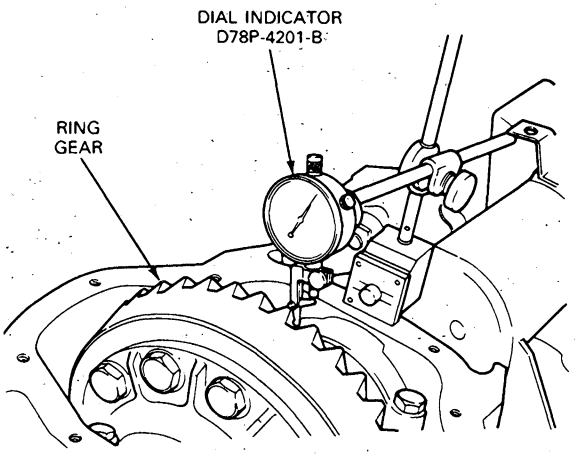
12. Check ring gear and pinion backlash in three equally spaced points with dial indicator.

    Backlash tolerance is 0.13-0.23mm (0.005-0.009 inch) and cannot vary more than 0.05mm (0.003 inch) between points checked.

    High backlash is corrected by moving the ring gear closer to the pinion.

    Low backlash is corrected by moving ring gear away from the pinion.

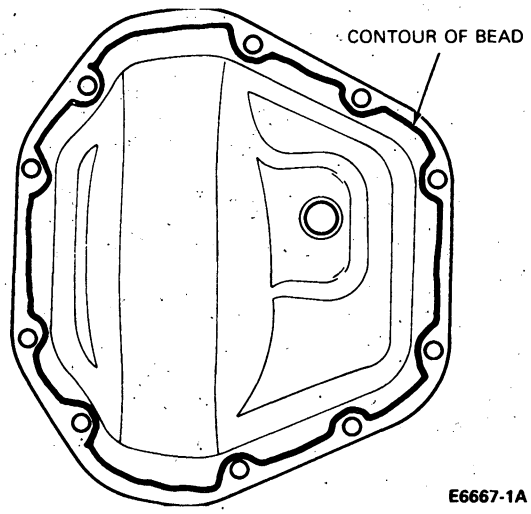
    These corrections are made by switching shims from one side of the differential case to the other.



E7500-1A

13. Obtain a gear tooth contact pattern. Check as outlined under 'Gear Tooth Contact Pattern Check' in this Section prior to complete reassembly.
14. Install new cover gasket and install cover plate. Tighten screws to torque specifications listed at the end of this Section.

NOTE: The flat mounting surface cover plate on Dana design axles requires the use of a silicone rubber sealer material, Silicone Rubber D6AZ-19562-AA (clear) or D6AZ-19562-BA (black) (ESB-M4G92-A and ESE-M4G195-A) or equivalent rather than a gasket.



E6667-1A

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

Sealant material must meet specifications of D6AZ-19562-AA or BB (ESB-M4G92-A), or equivalent.

Apply RTV Silicone Rubber Sealer D6AZ-19562-AA or BA, or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

The bead is to be 3.18-6.35mm (1/8 to 1/4 inch) wide.

Install two cover screws into cover at 8 o'clock and 2 o'clock positions. Use these two holes to guide cover plate into position on the carrier.

Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lb).

Allow one hour curing time before filling carrier with the proper amount of specified lubricant and vehicle operation.

15. Install the axle shafts as described under Axle Shaft in the Removal and Installation portion of this Section. Connect the steering linkage to the spindle.

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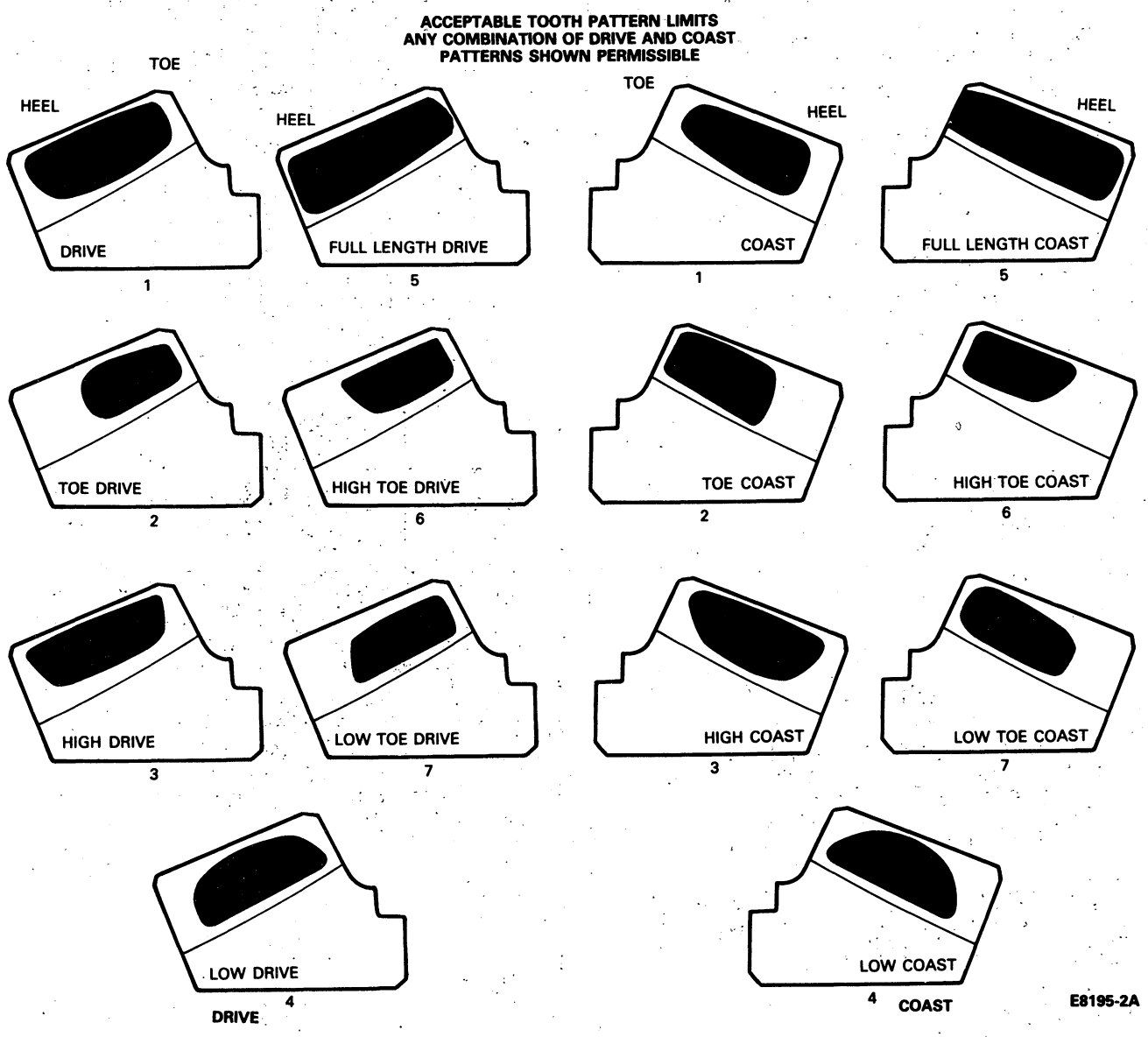
DISASSEMBLY AND ASSEMBLY (Continued)

Gear Tooth Contact Pattern Check

1. When rolling a teeth pattern, use a special marking compound (tube) to obtain gear tooth mesh contact pattern.
2. To check the gear tooth contact, paint the gear teeth with the special marking compound.

NOTE: A mixture that is too wet will run and smear, too dry a mixture cannot be pressed out from between the teeth.

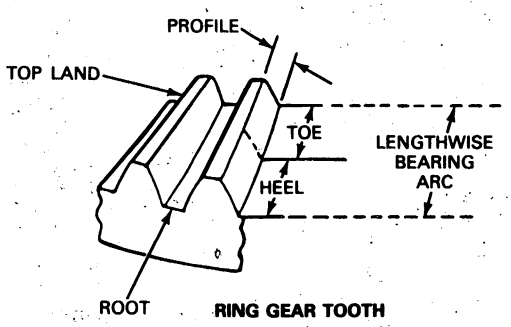
3. Rotate ring gear (use a box wrench on the ring gear attaching bolts as a lever several complete revolutions in both directions or until a clear tooth contact pattern is obtained.
4. Certain types of gear tooth contact patterns on the ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the ring gear and/or the pinion.



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DISASSEMBLY AND ASSEMBLY (Continued)

5. The previous illustration shows acceptable tooth patterns for all axles. In general, desirable tooth patterns should have the following characteristics:
   A. The drive pattern should be fairly well centered on the tooth.
   B. The coast pattern should be fairly well centered on the teeth.
   C. Some clearance between the pattern and the top of the tooth is desirable.
   D. There should be no hard lines where the pressure is high.
6. An individual gear set need not conform exactly to the ideal pattern to be acceptable. Any combination of drive and coast patterns show is acceptable.





PATTERN INTERPRETATION (RING GEAR)

NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

THE TOE OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE END TOWARDS THE CENTER. THE HEEL OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE OUTER END. THE TOP LAND OF A GEAR TOOTH IS THE SURFACE OF THE TOP OF THE TOOTH.

E8196-1A

7. Since each gear set rolls a characteristic pattern, the patterns shown are considered acceptable and should be used as a guide. the drive pattern is rolled on the convex side of the tooth, and the coast pattern is rolled on the concave side.

   The movement of tooth contact patterns with changes in shimming can be summarized as follows:
   A. Thinner shim, with the back lash set to specification, moves the pinion farther from the ring gear.
   B. Thicker shim, with the back lash set to specification, moves the pinion closer to the ring gear.

NOTE: When making pinion position changes, shims should be changed in the range of .05 mm (.002 inch) to .10 mm (.004 inch) until correct pattern has been obtained.

DRIVE SIDE HEEL	DRIVE SIDE TOE	COAST SIDE TOE	COAST SIDE HEEL	
				**BACKLASH CORRECT.** THINNER PINION POSITION SHIM SHIM REQUIRED.
				**BACKLASH CORRECT.** THICKER PINION POSITION SHIM REQUIRED.

THICKER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION CLOSER TO THE RING GEAR.
DRIVE PATTERN MOVES DEEPER ON THE TOOTH (FLANK CONTACT) AND SLIGHTLY TOWARD THE TOE.
COAST PATTERN MOVES DEEPER ON THE TOOTH AND TOWARD THE HEEL.
THINNER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION FURTHER FROM THE RING GEAR.
DRIVE PATTERN MOVES TOWARD THE TOP OF THE TOOTH (FACE CONTACT) AND TOWARD THE HEEL.
COAST PATTERN MOVES TOWARD THE TOP OF THE TOOTH AND SLIGHTLY TOWARD THE TOE.

E8197-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

8. If the pinion positioning shims are correct:
   - ecreasing backlash moves the ring gear closer to the pinion. Drive pattern (convex side of gear) moves slightly lower and toward the toe. Coast pattern (concave side of gear) moves lower and toward the toe.
   - ncreasing backlash moves the ring gear away from the pinion. Drive pattern moves slightly higher and toward the heel. Coast pattern moves higher and towards the heel.

NOTE: If the patterns are not correct, make the changes as indicated. The differential case and drive pinion will have to be removed from the carrier housing to change a shim.

DRIVE SIDE HEEL TOE	COAST SIDE TOE HEEL	
		PINION POSITION SHIM CORRECT. DECREASE BACKLASH.
		PINION POSITION SHIM CORRECT. INCREASE BACKLASH.

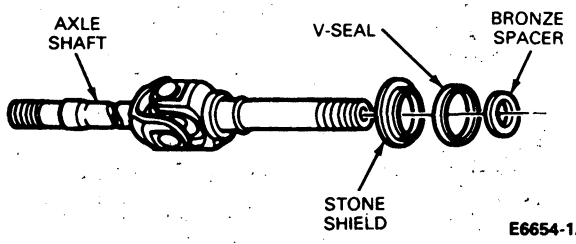
HIGH BACKLASH IS CORRECTED BY MOVING THE RING GEAR CLOSER TO THE PINION. LOW BACKLASH IS CORRECTED BY MOVING THE RING GEAR AWAY FROM THE PINION. THESE CORRECTIONS ARE MADE BY SWITCHING SHIMS FROM ONE SIDE OF THE DIFFERENTIAL CASE TO THE OTHER.

E8198-1A

9. Check ring gear backlash by installing a dial indicator on the carrier housing. Check ring gear and pinion backlash at three equally spaced points on the ring gear. Backlash tolerance is 0.13-0.23 mm (0.005-0.009 inch) and cannot vary more than 0.08 mm (0.003 inch) between the three points. If backlash is high, the ring gear must be moved closer to the pinion, by moving shims too the ring gear side to the opposite side. If backlash is low, the ring gear must be moved away from the pinion by moving shims from the ring gear side to the opposite side.

NOTE: When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .10 mm (.004 inch), the shim pack should be changed by .15 mm (.006 inch) as a starting point. The actual amount of backlash change obtained will vary depending upon the ratio and gear size.

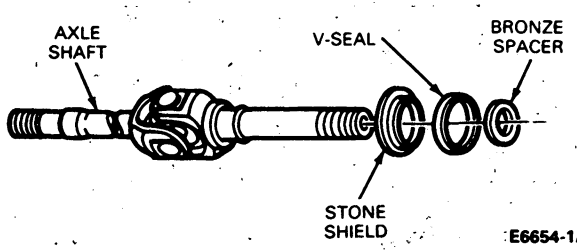
Axle Shaft



E6654-1A

Disassembly

1. Remove the axle shaft as described under Axle Shaft in the Removal and Installation portion of this Section.
2. If installed, remove the bronze spacer from the axle shaft.
3. Remove the rubber V-seal from the stone shield and axle shaft.

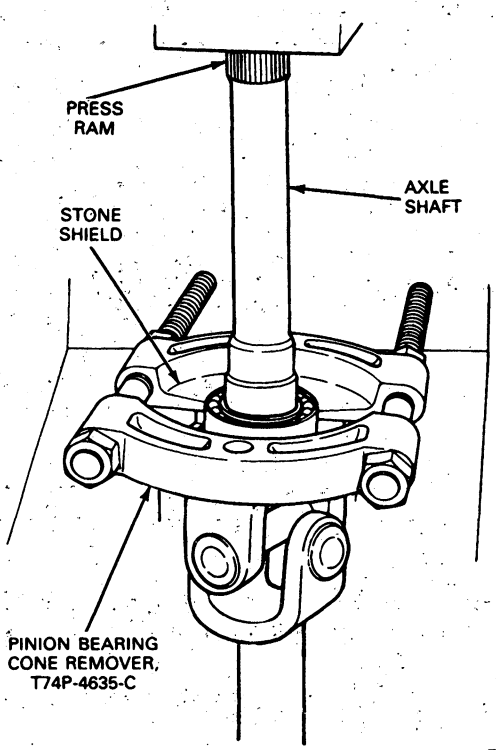


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DISASSEMBLY AND ASSEMBLY (Continued)

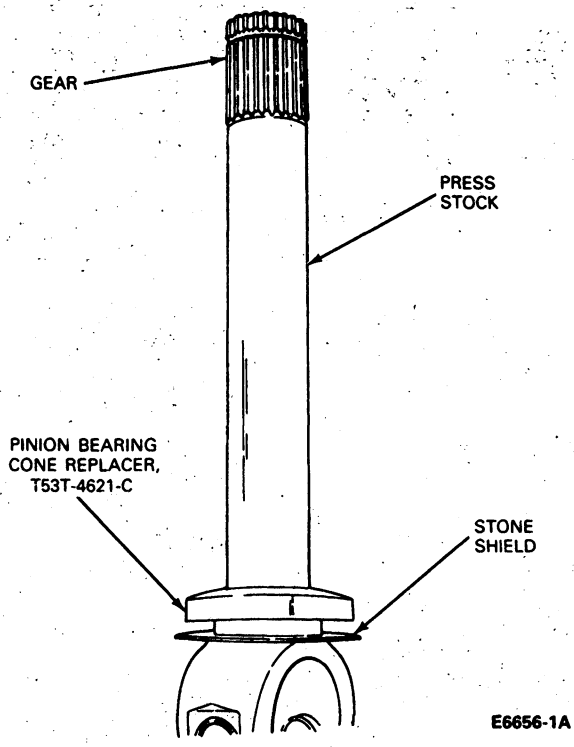
4. If required, remove the stone shield from the axle shaft with a press and Pinion Bearing Cone Remover, D79L-4621-A or equivalent. Discard the stone shield.
5. Remove the snap rings that retain the bearings in the yoke and axle shaft.
6. Position U-Joint Tool, T74P-4635-C or equivalent on the shaft and press the bearings out of the yoke. If the bearing cannot be pressed completely out of the yoke, remove the bearing with vise grip or channel lock pliers. Mark the yoke and shaft so they can be assembled in the same position.
7. Re-position the tool to press on the spider in order to remove the bearing from the opposite side of the yoke.
8. Remove the yoke from the spider.
9. Remove the bearings and spider from the axle shaft in the same manner.



Assembly

1. Start a new bearing into the axle shaft.
2. Position the spider in the axle shaft and press the bearing 6mm (1/4 inch) below the axle shaft surface using U-Joint Tool, T74P-4635-C or equivalent.
3. Remove the tool and install a new snap ring.
4. Start a new bearing on the opposite side of the axle shaft.
5. Install the U-Joint Tool and press the bearing until the snap ring of the opposite bearing contacts the axle shaft.
6. Remove the tool and install a new snap ring.
7. Install the yoke on the spider in position marked during disassembly.
8. Install two new bearings and snap rings in the yoke and spider in the same manner as the axle shaft.
9. Check the U-joint for freedom of movement. If a binding condition results, tap the ears of the axle shaft sharply to relieve the binding. **DO NOT INSTALL AN AXLE SHAFT IF THE U-JOINT SHOWS SIGNS OF BINDING.**
10. If removed, press a new stone shield on the axle shaft with an appropriate piece of press stock and Pinion Bearing Cone Replacer, T53T-4621-C or equivalent.
11. Install the rubber V-seal on the stone shield and axle shaft. The lip of the seal should face towards the spindle.
12. If removed, install the bronze spacer on the axle shaft. The chamferred side of the spacer should be inboard against the axle shaft.

STONE SHIELD INSTALLATION



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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Number	Description
D78P-4201-B	Dial Indicator	T57T-4851-B	Companion Flange Holding Tool
D79L-4621-A	Pinion Bearing Cone Remover	T64P-3590-F	Pitman Arm Puller
D80L-100-H	Actuator Pin	T65L-4851-B	End Yoke Remover
D80L-100-W	Bridge Assembly	T74P-4635-C	U-Joint Tool
D80L-100-T	Collet	T75L-1165-B	Axle Bearing/Seal Plate
D80L-630-7	Step Plate	T75L-1165-DA	Axle Bearing/Seal Replacer
T86T-3110-AH	King Pin Seal Installer	T75T-1176-A	Threaded Drawbar
D80T-4020-F48	Gauge Tube	T76P-4020-A3	Aligning Adapter
D81L-4000-A	Dirver Handle	T76P-4020-A11	Handle
D81T-4020-F54	Final Check Gauge Block	T77F-1102-A	Bearing Cup Puller
D81L-4220-A	Universal Bearing Remover	T77L-9533-B	Jet Plug Puller
D81T-4221-A	Differential Side Bearing Replacer	T78P-4020-A15	Gauge Disc
D81T-4222-D	Master Differential Bearings	T78P-4851-A	Holding Tool
D81T-4628-A	Bearing Cup Remover	T80T-4000-R	Bearing Replacer
D81T-4628-D	Bearing Cup Remover	T80T-4000-W	Driver Handle
D81T-4858-A	Companion Flange Replacer	T80T-4020-F42	Gauge Block
D85L-1039-A	Two-Jaw Puller	T80T-4020-F43	Screw
D85T-1197-A	Spanner Locknut Wrench	T83T-4676-A	Oil Seal Replacer
T50T-100-A	Slide Hammer	TOOL-1175-AC	Seal Remover
T53T-4621-C	Pinion Bearing Cone Replacer	TOOL-4000-E	Differential Housing Spreader
T56T-4616-B1	Outer Bearing Cup Replacer	TOOL-4201-C	Dial Indicator
T56T-4616-B2	Inner Bearing Cup Replacer	TOOL-4858-E	Companion Flange Replacer
T56T-4676-B	Oil Seal Replacer		

CE6660-2C

TORQUE SPECIFICATIONS — DANA MODEL 60 FRONT DRIVE AXLE

Description	N·m	Ft-Lbs
Pinion Shaft Nut	298-379	220-280
Differential Bearing Cap Capscrews	108-122	80-90
Ring Gear Bolts/Nuts ①	136-163	100-120
Oil Filler Plug	26-40	20-30
U-Joint U-Bolt Nuts	21-27	15-20
Cover-To-Housing Bolts	41-54	30-40
Tracking Bar Nut & Bolt	221-275	163-203
Kingpin	678-813	500-600
Steering Cap Nuts	95-122	70-90
Stabilizer Link Nut	28-48	21-33
Stabilizer Bar U-Bolt	65-92	48-68
Spindle Connecting Rod To Steering Knuckle Castellated Nut	95-136	70-100
Stabilizer Bar Bracket U-Bolt	65-92	48-68

① If equipped with Grade 9 bolts C7 lines on bolt head, tighten to 163-190 N·m (120-140 ft-lbs).

CE6657-1B

ROTUNDA EQUIPMENT

Model Number	Description
014-00257	Differential Repair Stand
077-00008	Low Lift Transmission Jack

CE6662-1A

DANA AXLE ADJUSTMENTS

Description	Specification	Description	Specification
Backlash Between Ring Gear and Pinion	0.13-0.23 mm (0.005-0.009 inch)	Pinion Bearing Preload (with new bearings)	2.26-4.53 N·m (20-40 in-lbs)
Backlash Maximum Variation Between Teeth	0.05 mm (0.002 inch)		

CE6659-2A

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SPECIFICATIONS (Continued)

AXLE LUBRICANT CAPACITIES

Axle Model	Ford Specification	Approx. Capacities		
		U.S. Pts.	Imp. Pts.	Liters
60	Hypoid Gear Lubricant, C6AZ-19580-E (CESW-M2C105-A) or equivalent	5.8	4.8	2.8

CE6658-2A

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SECTION 15-34 Front Drive Axles—Dana Model 44 and 50

SUBJECT	PAGE
ADJUSTMENTS	15-34-6
DESCRIPTION AND OPERATION	
Automatic Locking Hubs Operation (Optional on Bronco and F-150 (4x4))	15-34-6
Free Running Position—Manual Locking Hubs	15-34-6
Front-Wheel Drive Manual Hub	15-34-1
Lock Position	15-34-1
DIAGNOSIS AND TESTING	15-34-6
DISASSEMBLY AND ASSEMBLY	
Bearing Cup and Drive Pinion Installation	15-34-22
Cardan Type U-Joints	15-34-18
Carrier	15-34-18
Depth Gauge Check	15-34-21
Differential Case	15-34-23
Drive Pinion Installation	15-34-20
Drive Pinion Preload Check	15-34-23
Gear Tooth Contact Pattern Check	15-34-26
DISASSEMBLY AND ASSEMBLY (Cont'd)	
Total Differential Case Endplay	15-34-20
REMOVAL AND INSTALLATION	
Axle Housing Pivot Bushing (IFS Front Drive Axle)	15-34-17
Axle Shaft Bearing (IFS Front Drive Axle)	15-34-17
Dana Four Wheel Drive Front Axle	15-34-6
F-150 (4x4) and Bronco With Coil Springs	15-34-6
Left Differential Seal	15-34-17
Right Hand Slip Yoke and Stub Shaft Assembly, Carrier, Carrier Oil Seal, and Bearing	15-34-14
Spindle, and Right and Left Shaft and Joint Assembly	15-34-11
Steering Knuckle	15-34-8
SPECIFICATIONS	15-34-29
VEHICLE APPLICATION	15-34-1

VEHICLE APPLICATION

All F-150—F-250 (4x4) and Bronco Vehicles.

DESCRIPTION AND OPERATION

Three types of Dana front-drive axles are available for Ford light truck application. The Dana 44-IFS (Independent Front Suspension) is available on Bronco and F-150 (4x4). The Dana 44-IFS-HD (Independent Front Suspension—Heavy Duty) is available on F-250 (4x4). The Dana 50-IFS (Independent Front Suspension) is available on F-250 (4x4) equipped with Heavy Duty Front End option or F-250 Super Cab models.

All axles are basically alike with some differences between the three. The 44-IFS is on vehicles equipped with front coil springs. The 44IFS HD and 50 IFS are on vehicles equipped with front leaf springs.

The 44-IFS (Fig. 1) is equipped with automatic hubs and is equipped with manual hublocks (Fig. 2). The 44-IFS-HD (Fig. 3) and 50-IFS (Fig. 4) axles equipped with manual locking hubs only.

The differential carrier is mounted to the left hand axle arm. Adjustment of the differential bearings is accomplished by means of shims placed between the bearings and the differential case. The differential bearings are preloaded by the squeezing action of the carrier housing. A spreader must be used on the axle housing to relieve the tension on the differential bearings and permit removal or installation of the differential.

The front axle is of the integral carrier-housing, hypoid-gear type, in which the centerline of the drive pinion is mounted above the centerline of the ring gear.

The integral drive pinion gear and shaft is supported by two opposed tapered roller bearings which are assembled in the carrier housing. Pinion locating shims, installed between the inner bearing cup and the cup seat, control the drive pinion depth adjustment. The pinion bearing preload is controlled by shims located between the pinion outer bearing and the shoulder on the drive pinion shaft.

The differential case assembly is supported by two opposed tapered roller bearings and cups, which are retained in the housing by removable caps. Shims, installed between each differential bearing and the shoulder on the case, perform three functions: they take up the differential case side clearance; they adjust the backlash between ring gear and drive pinion, and they establish differential side bearing preload.

On IFS front driving axles, the cover on the front of the carrier housing is integral with the left hand axle arm assembly. A metal tag, stamped with the gear ratio and part number is secured to the housing by one of the carrier mounting bolts (Section 15-01, General Driving Axle and Driveshaft Service).

Front-Wheel Drive Manual Hub

For service procedures on front hubs, refer to Section 11-12 Wheel Hubs and Bearings Front Wheel Drive.

The manual locking hub is standard equipment for the Dana front axle of the Bronco and F-150 (4x4). It is the internal locking type. The automatic locking hubs are optional on F-150 (4x4) and Bronco.

Lock Position

Refer to Fig. 5.

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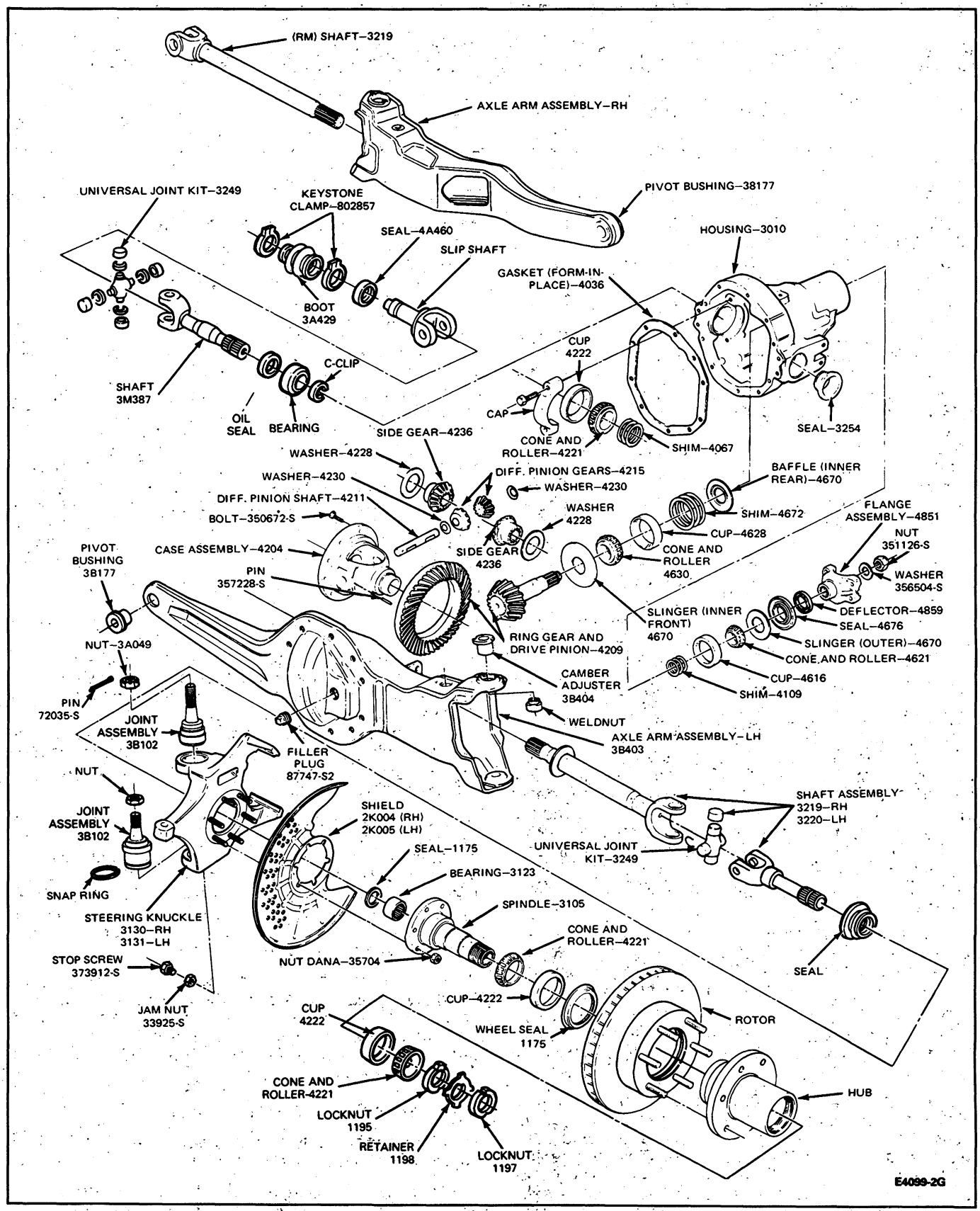


FIG. 1 Dana 44-IFS Front Drive Axle Bronco and F-150 (4x4) with Automatic Hublocks

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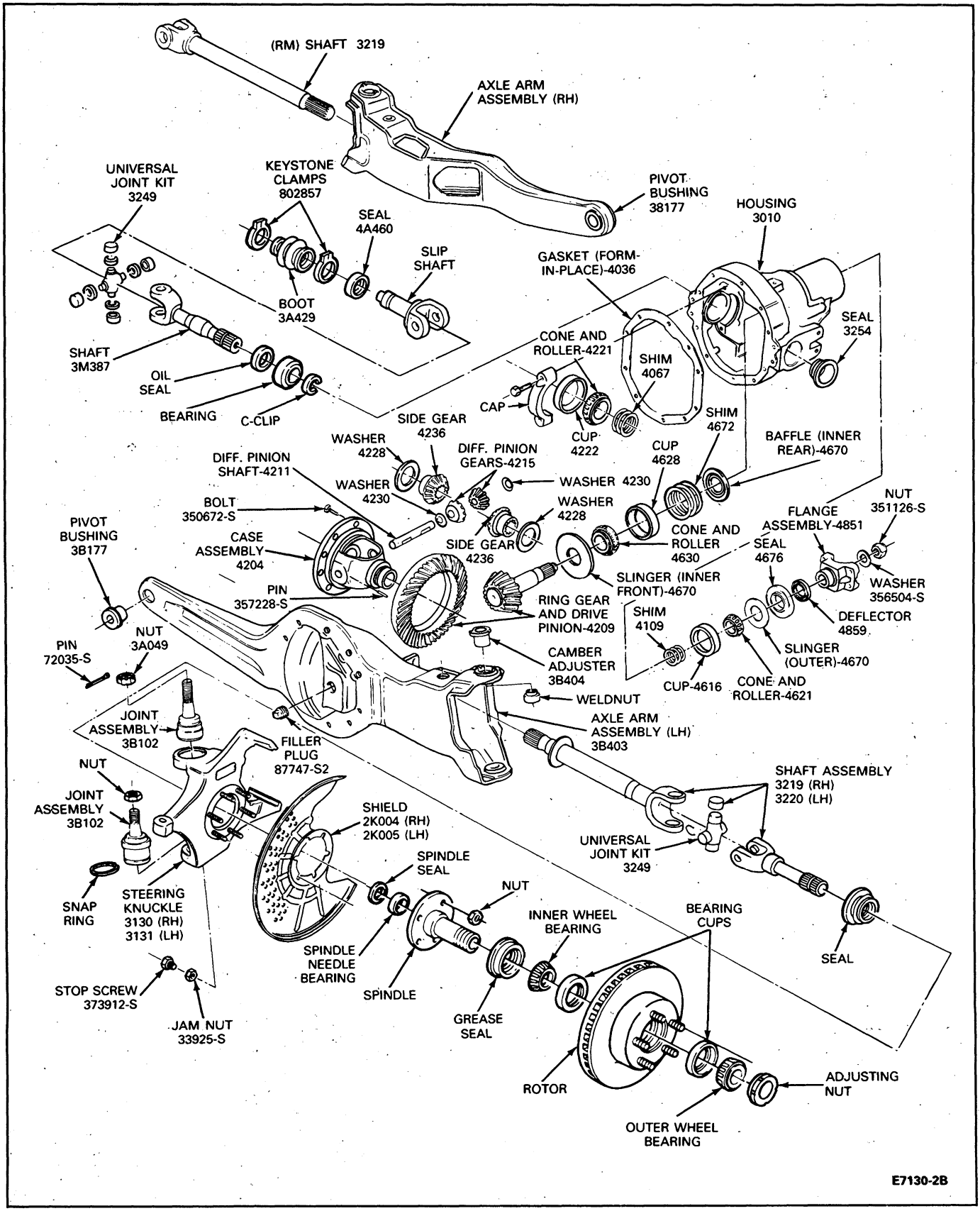


FIG. 2 Dana 44-IFS Front Drive Axle Bronco and F-150 (4x4) with Manual Hublocks

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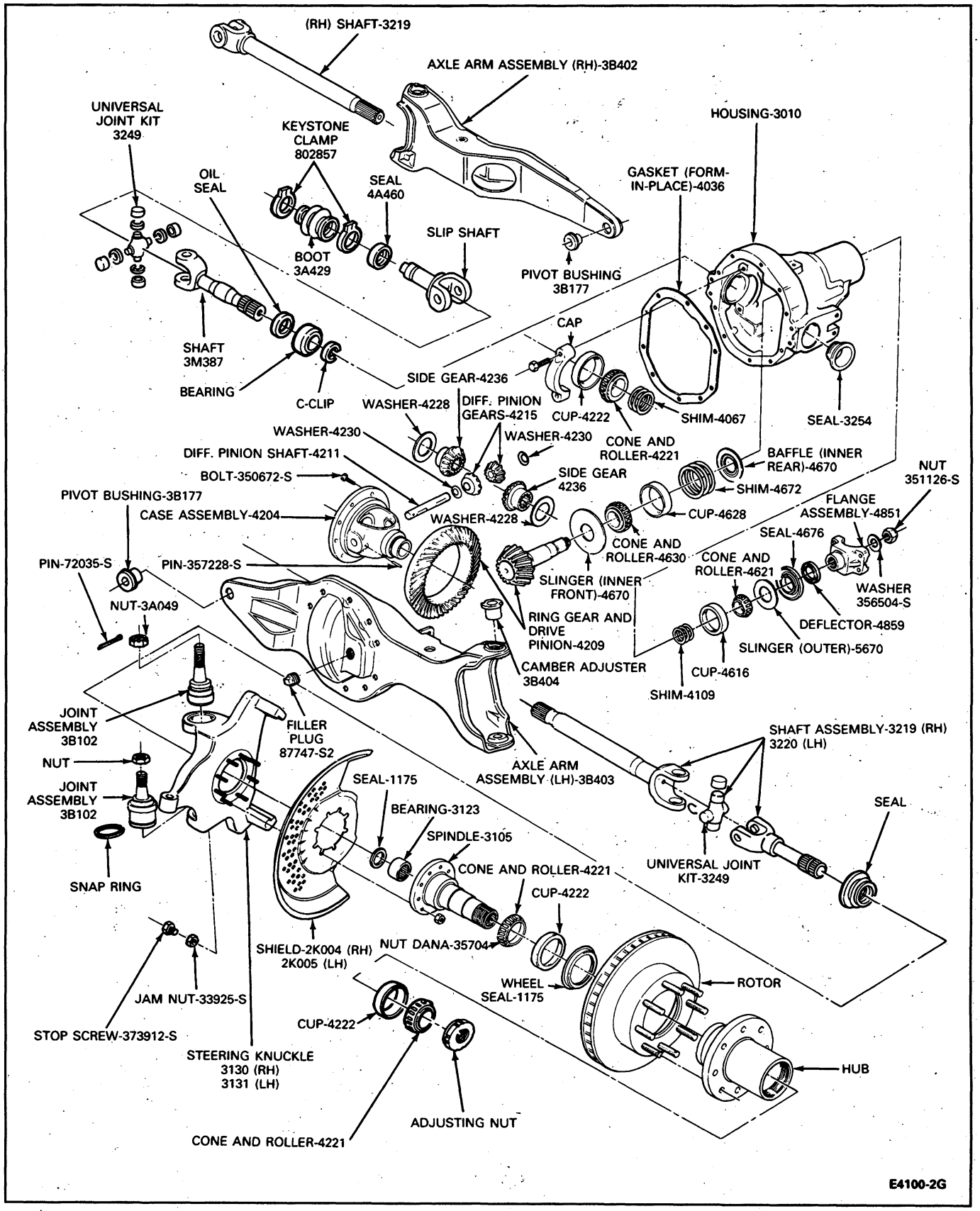


FIG. 3 Dana 44-IFS-HD-Front Driving Axle F-250 L.D.(4x4)

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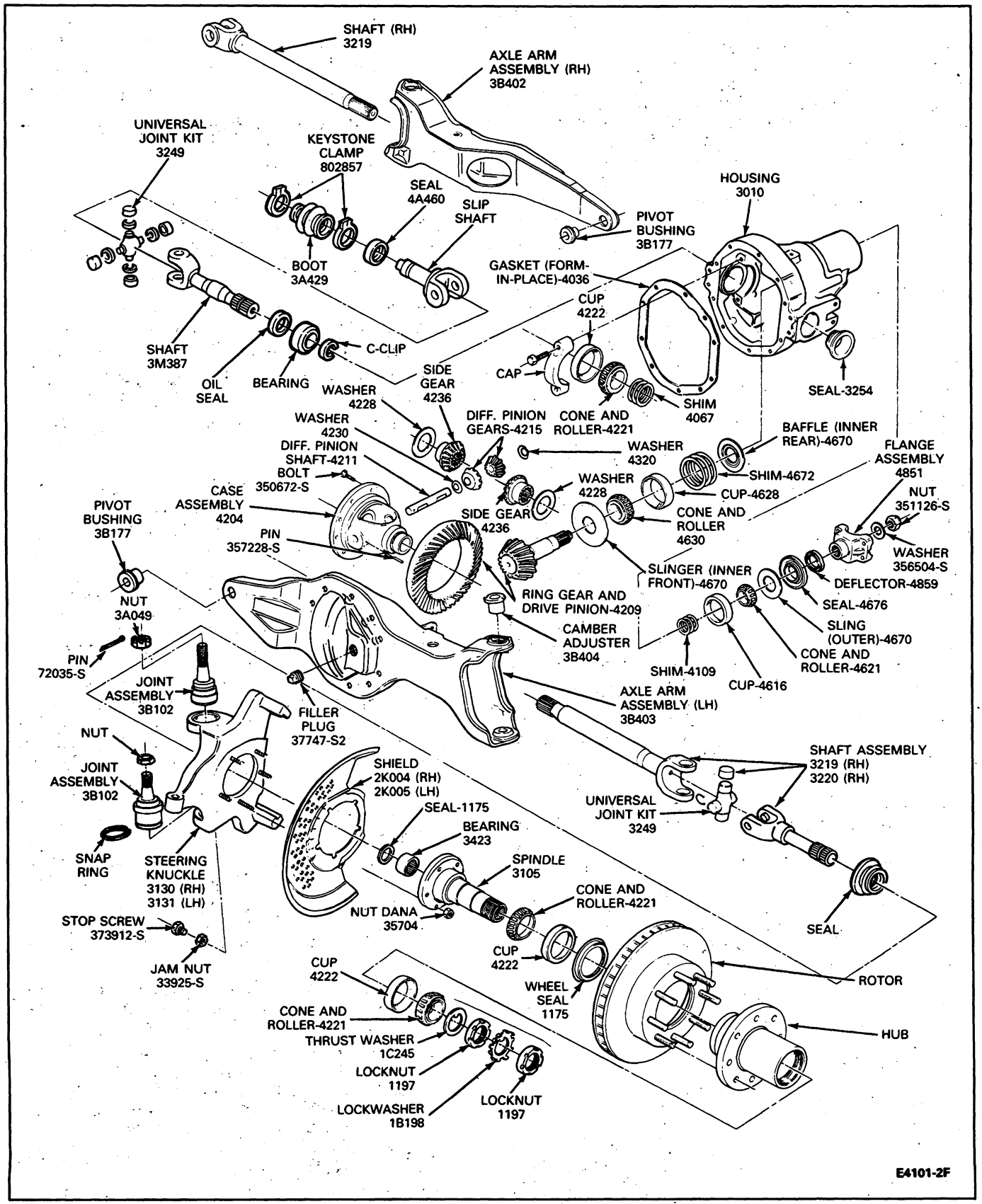


FIG. 4 Dana 50-IFS-Front Drive Axle F-250 H.D. (4x4)

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When the transfer case is to be shifted into the position for driving the front axle, the pointer on the center bar of the hub must point to the pointer over the word LOCK on the Hub Lock Cap. If the clutch teeth do not engage with the knob turned to this position, the clutch teeth are butted and a slight movement of the wheel in either direction will complete the lock. The front axle will now drive the wheels. Do not operate in four-wheel drive with the hubs disengaged.

Free Running Position—Manual Locking Hubs

When the transfer case is to be shifted into the position for driving the rear axle only, turn the pointer on the center bar of the hub so it points to the pointer over the word FREE on the Hub Lock Cap. This will disengage the clutch teeth and thus unlock the wheel hubs from the axle shafts. The wheels will turn freely on the axles.

Be certain that the transfer case is shifted into two-wheel drive position before disengaging the free running hubs.

If difficulty is experienced in disengagement of the free running hubs, a slight movement of the vehicle in either direction with the transfer case in 2 wheel drive position, will reduce driveline wrap-up and ease disengagement.

Automatic Locking Hubs Operation (Optional on Bronco and F-150 (4x4))

Four-Wheel Drive—The vehicle must be stopped when you first shift into four-wheel drive. Place the transmission in neutral and the transfer case selector in the 4H or 4L position. The hublocks will automatically engage when the vehicle is driven. The transfer case may then be shifted between 2H and 4H with the vehicle moving, as long as the automatic hub locks remain engaged. The hubs will remain engaged until the disengage sequence is performed.

Two-Wheel Drive—Place the transfer case in the 2H position. To disengage the automatic hub locks, shift the transmission to move the vehicle in the opposite direction (forward or reverse) and drive a minimum of 10 ft. (30 m) in a straight line.

CAUTION—Never shift from 2H to 4H with the automatic hub locks disengaged while the vehicle is in motion. If it is necessary to shift to or from 4L, bring the vehicle to a full stop before doing so.

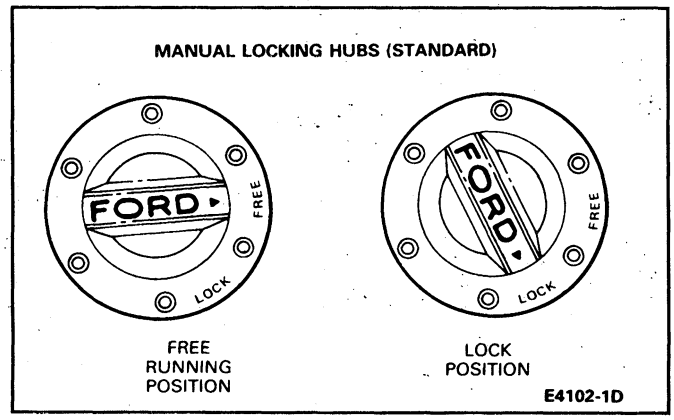


FIG. 5 Four Wheel Drive Wheel Hubs

DIAGNOSIS AND TESTING

Refer to Section 15-01, General Driving Axle Service Under Diagnosis and Testing.

ADJUSTMENTS

Refer to Section 14-01, General Suspension Service for alignment procedures.

REMOVAL AND INSTALLATION

Dana Four Wheel Drive Front Axle

F-150 (4x4) and Bronco With Coil Springs (Fig. 6)

Removal

1. Raise the vehicle on a hoist or jack and install safety stands under the radius arm brackets.
2. Remove the wheel and tire assembly and brake caliper.
3. Disconnect the steering linkage from the steering knuckles according to the procedures in Section 13-24.
4. Position jack under axle arm assembly and remove the upper coil spring retainers. Lower the jack and remove the coil spring, spring cushion and lower spring seat.

   NOTE: The axle arm assembly must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for the removal and installation of the spring, the disc brake caliper must be removed according to the procedures specified in Section 12-24, Disc Brakes—Light and Heavy Duty Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.
5. Disconnect the shock absorber at the radius arm and upper mounting bracket.
6. Remove the stud and spring seat at radius arm and axle arm. Remove bolt securing upper attachment to axle arm radius arm to lower attachment axle arm.
7. Disconnect the vent tube at the differential housing and discard the hose clamps. Remove the vent fitting and install a 1/8 inch pipe plug.
8. Remove the pivot bolt securing the right hand axle arm assembly to crossmember. Remove and discard the keystone clamps and remove the boot from the shaft. Remove the right drive axle assembly and pull the axle shaft from the slip shaft.
9. Position a jack under the differential housing. Remove the bolt securing the left hand axle assembly to the crossmember. Remove the left hand drive axle assembly.

Installation

1. Raise the vehicle on a hoist or a jack and position the left drive axle assembly at the radius arm. Secure the drive axle to crossmember with the

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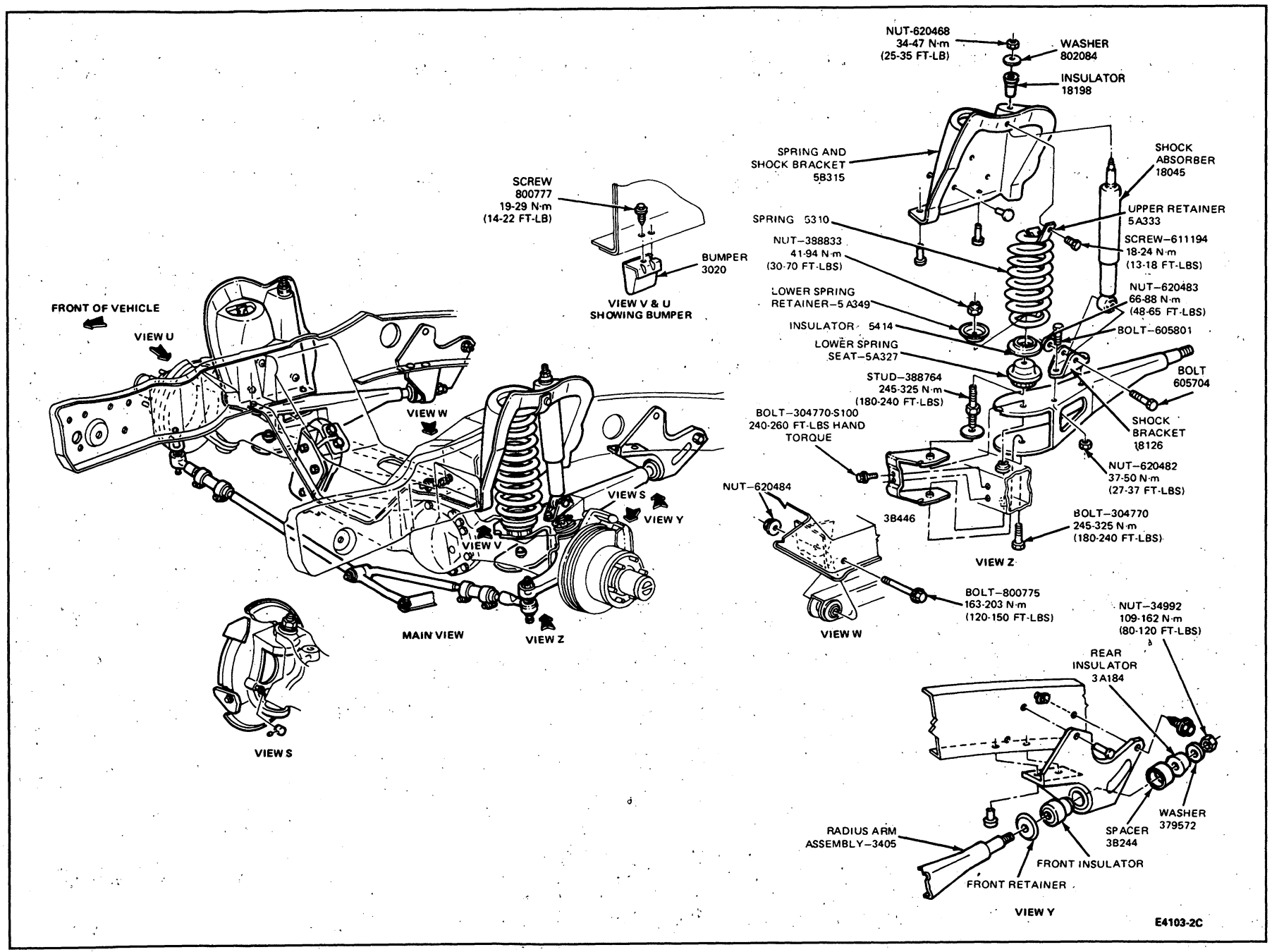


FIG. 6 Front Suspension Bronco F-150 (4x4)

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pivot bolt. Tighten bolt to 163-203 N·m (120-150 ft-lbs).

2. Position the right hand axle assembly at the crossmember and radius arm. Align the axle shaft and install in slip shaft. Install the boot on the shaft so the boot seats in the grooves. Position new Keystone Clamps over the grooves on the boot and crimp the clamp with Keystone Clamp Pliers, T63P-9171-A or equivalent. Secure axle assembly to crossmember with pivot bolt. Tighten to 163-203 N·m (120-150 ft-lbs).
3. Install vent fitting in differential housing. Connect vent tube to vent fitting using new hose clamps.
4. Position spring seat and install a new stud at axle arm and upper radius arm. Install new bolt at axle assembly and lower radius arm. Tighten bolts to 245-325 N·m (180-240 ft-lbs).
5. Position coil spring insulator and coil spring on lower spring seat. Install nut and tighten to 41-94 N·m (30-70 ft-lbs). Position jack under axle assembly and raise coil spring into position. Install upper spring retainer and screw. Tighten to 18-24 N·m (13-18 ft-lbs).
6. Lower the jack.
7. Connect shock absorbers to upper and lower frame brackets.
8. Install brake caliper and wheel and tire assembly.
9. Connect the steering linkage as outlined in section 16-24.
10. Lower the vehicle and check and adjust camber and toe-in according to Section 14-01, General Suspension Service.

F-250 (4x4)—Leaf Spring Front Suspension

Refer to Fig. 7.

Removal

1. Raise vehicle on a hoist or jack and install safety stands.
2. Remove the wheel and tire assemblies, and brake calipers.

   NOTE: Do not let the caliper hang with it's weight on the brake hose or the hose may become stretched or twisted.
3. Disconnect the steering linkage from the steering knuckles according to the procedures in Section 13-24.
4. Position jack under right hand axle assembly. Remove the two U-bolts securing the shock absorber mounting plate and leaf springs to tube and yoke assembly.
5. Disconnect the vent tube at the differential housing. Remove the vent fitting and install a 1/8 inch pipe plug.
6. Remove the pivot bolt that secures the right hand axle assembly to crossmember. Remove the RH axle assembly. Remove and discard the keystone clamps and remove the boot from the shaft. Pull the axle shaft out of the slip shaft.
7. Position the jack under the left hand axle assembly. Remove the two U-bolts securing the shock absorber mounting plate and leaf spring to tube and yoke assembly.
8. Position a jack under the differential housing.
9. Remove the pivot bolt securing the left hand axle assembly to crossmember. Remove the left axle assembly.

Installation

1. Raise vehicle on a hoist or a jack and position left hand axle assembly at leaf spring assembly. Install the pivot bolt that secures the axle assembly to the crossmember. Secure the shock absorber mounting plate to the leaf spring and axle assembly with the two U-bolts. Tighten bolts to 116-162 N·m (85-120 ft-lbs).
2. Position the right hand axle assembly at crossmember. Install the boot on the shaft so the boot seats in the grooves. Position new Keystone Clamps over the grooves on the boot and crimp the clamp with Keystone Clamp Pliers, T63P-9171-A or equivalent. Align the axle shaft and install in slip shaft. Install the pivot bolt that secures the axle assembly to crossmember. Tighten bolt to 123-203 N·m (120-150 ft-lbs). Install shock absorber mounting plate, leaf spring and axle assembly using two U-bolts. Tighten bolts to 116-162 N·m (85-120 ft-lbs).
3. Install vent fitting to differential housing and connect vent tube to vent using a new hose clamp.
4. Connect the steering linkage.
5. Install brake caliper and wheel and tire assembly.
6. Check and adjust caster, camber and toe-in.

Steering Knuckle

Removal

Refer to Fig. 8.

1. Remove the spindle and the right and left shaft and joint assembly as described in this Section.
2. Disconnect the steering linkage, if necessary, from the knuckle according to the procedures in Section 13-24.
3. Remove the cotter pin from the top ball joint stud. Loosen the nut on the top stud and the bottom nut inside the knuckle (Fig. 9). Remove the top nut.
4. Sharply hit the top stud with a plastic or rawhide hammer to free the knuckle from the axle arm. Remove and discard bottom nut. Use new nut upon assembly.
5. Remove camber adjuster by hand or if difficulty is encountered use Pitman Arm Puller T64P-3590-F or equivalent (Fig. 10).

   Note the orientation of the camber adjuster to assure the same camber setting.
6. Place knuckle in vise and remove snap ring from bottom ball joint socket if so equipped.
7. Remove plug from C-Frame Assembly (T74P-4635-C) and replace with Plug (T80T-3010-A4) or equivalent. (View A, Fig. 11.)
8. Assemble C-Frame Assembly and Receiving Cup (T80T-3010-A2 for F-350 or D81T-3010-A for F-150 and F-250) as shown in View B, Fig. 11.
9. Turn forcing screw clockwise until ball joint is removed from steering knuckle.
10. Assemble C-Frame Assembly and Receiving Cup (D81T-3010-A) or equivalent on upper ball joint

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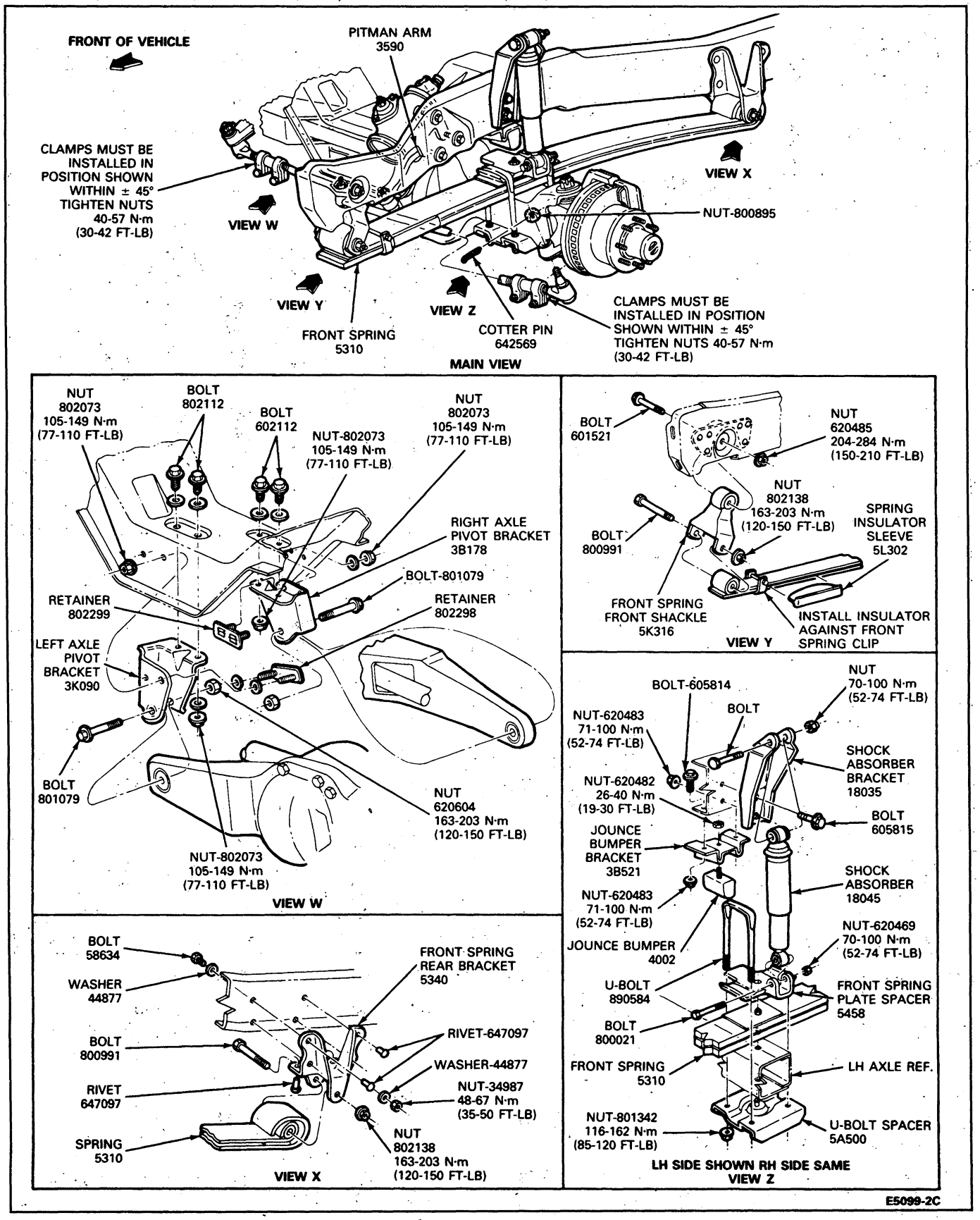


FIG. 7 Front Driving Axle—F-250 (4x4)

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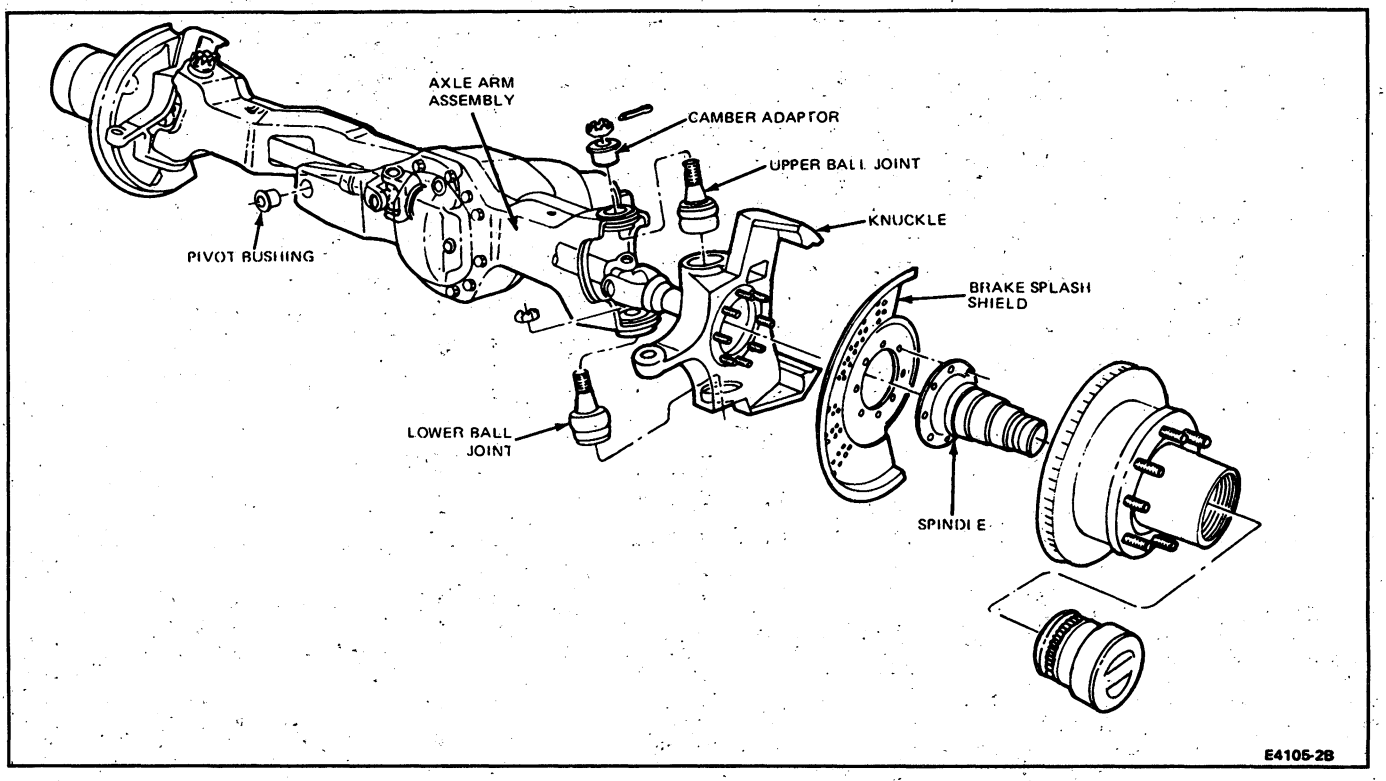


FIG. 8 Knuckle and Spindle—Exploded View

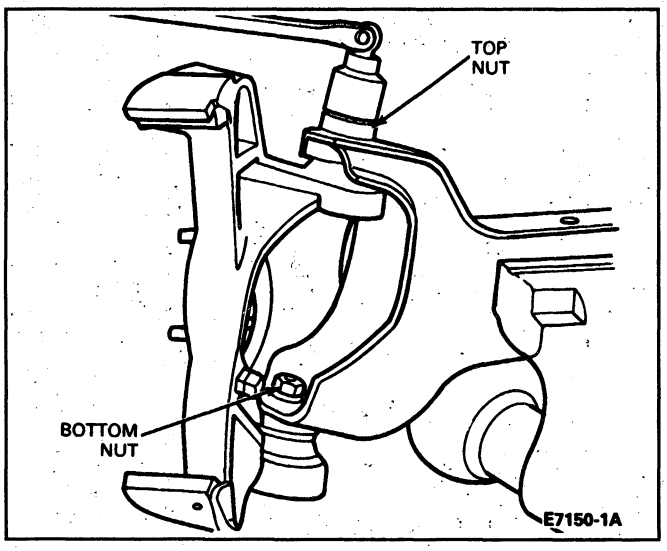


FIG. 9 Removing Steering Knuckle Nut

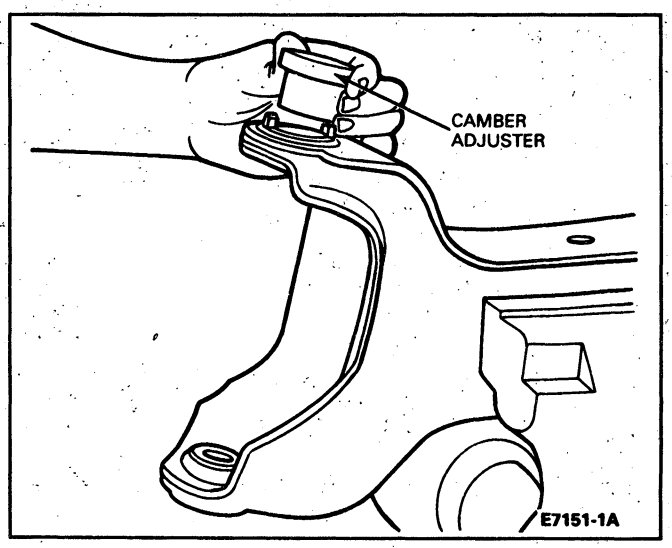


FIG. 10 Removing Camber Adjuster

and turn forcing screw clockwise until ball joint is removed.

NOTE: Always remove bottom ball joint first.

Installation

1. Clean steering knuckle bore and insert lower ball joint as straight as possible.
2. Assemble C-Frame Assembly, Ball Joint Receiving Cup (T80T-3010-A3) and installing Cup (D81T-3010-A) or equivalents as shown in View A, Fig. 12 to replace the lower ball joint on the F-150—F-250 and Bronco (Dana 44).
3. Assemble C-Frame, Receiving Cup (T80T-3010-A3) and Receiving Cup (D81T-3010-A) or equivalents as shown in View B, Fig. 12 to replace the lower ball joint on the F-350 (Dana 50).
4. Turn forcing screw clockwise until ball joint is firmly seated.

   NOTE: If ball joint cannot be installed to the proper depth, realignment of Receiving Cup (T80T-3010-A3) will be necessary. Install the snap ring on the lower ball joint.
5. To install upper ball joint on the F-150, F-250, F-350 and Bronco assemble the C-Frame, Receiving Cup (T80T-3010-A3) and Replacer (T80T-3010-A1) or their equivalents as shown in View C, Fig. 12 and repeat Step 4.
6. Assemble knuckle to axle arm assembly. Install Camber adjuster on top ball joint stud with the

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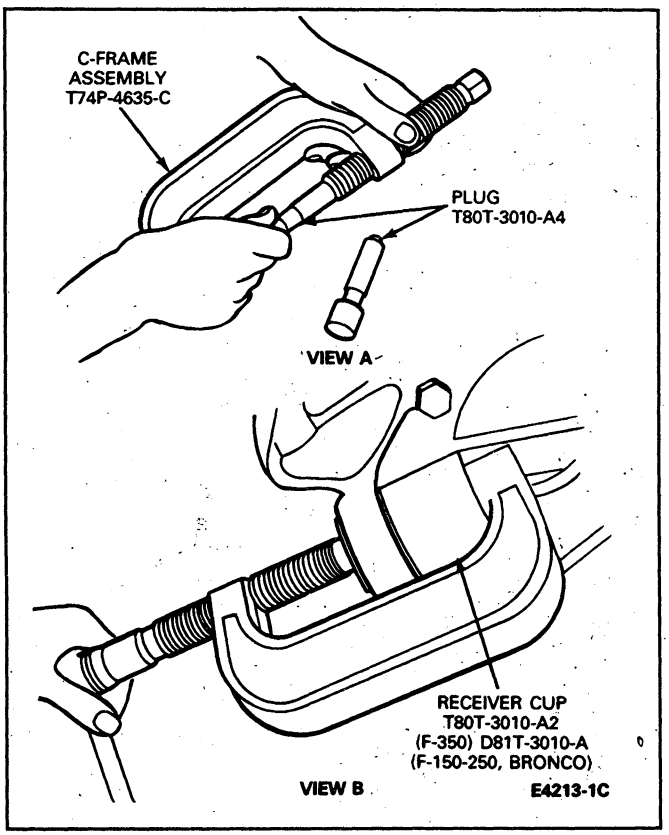


FIG. 11 Upper Ball Joint Removal

arrow pointing outboard for "positive" camber, pointed inboard for "negative" camber.

7. Install new nut on bottom socket finger tight. Install and tighten nut on top socket finger tight. Tighten bottom nut to 109 N·m (80 ft-lbs).
8. Tighten top nut to 136 N·m (100 ft-lbs), then advance nut until castellation aligns with cotter pin hole. Install cotter pin.

   NOTE: Do not loosen top nut to install cotter pin.
9. Retighten bottom nut to 123-150 N·m (90-110 ft-lbs).
10. Install the spindle and the right and left shaft and joint assembly as described in this Section.

Spindle, and Right and Left Shaft and Joint Assembly

Refer to Figs. 13 and 14.

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. Securely wire the caliper to the frame.

CAUTION: After removal, the caliper must be wired to the frame or otherwise supported to prevent suspending the caliper by the flexible hose. If securing the caliper is not practical, disconnect and plug the hose to the caliper. Upon caliper installation, bleed the brake system as described in Section 12-01, General Hydraulic Brake Service.

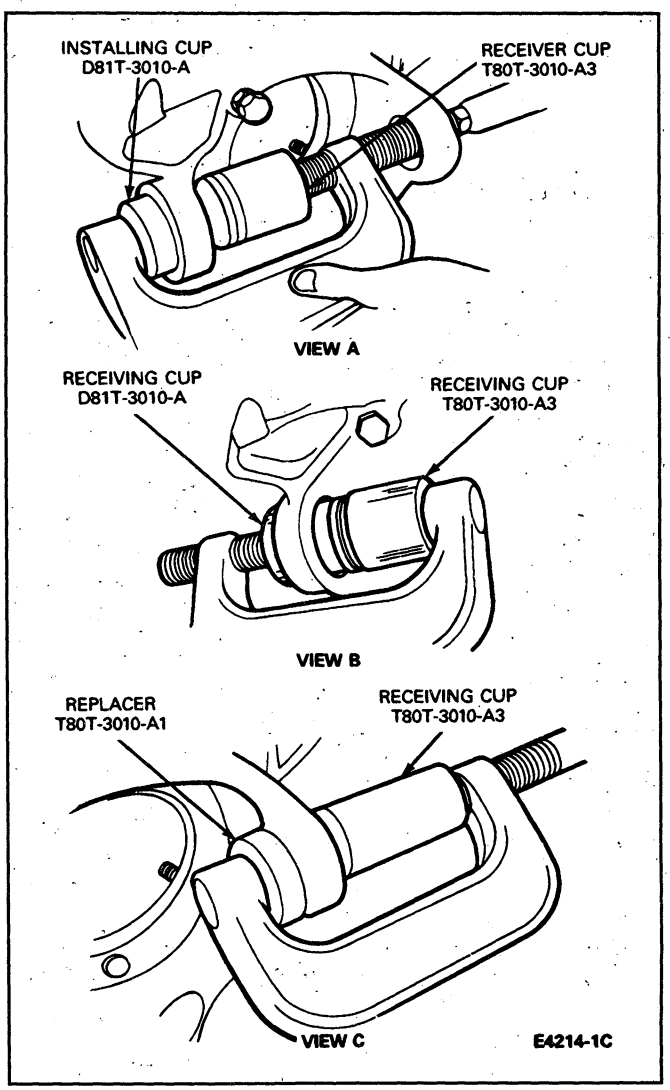


FIG. 12 Ball Joint Installation

4. Remove hub locks, wheel bearings, and lock nuts per Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive.
5. Remove the hub and rotor assembly and outer bearing from the spindle.
6. Remove the nuts retaining the spindle to the steering knuckle. Tap the spindle with a plastic or rawhide hammer to jar the spindle from the knuckle. Remove the splash shield.
7. On the right side of the vehicle remove the shaft and joint assembly by pulling the assembly out of the carrier (Fig. 15).
8. On the right side of the carrier, remove and discard the keystone clamp from the shaft and joint assembly and the stub shaft. Slide the rubber boot onto the stub shaft and pull the shaft and joint assembly from the splines of the stub shaft (Fig. 16).
9. Place the spindle in a vise on the second step of the spindle. Wrap a shop towel around the spindle or use a brass-jawed vise to protect the spindle.
10. Remove the oil seal and needle bearing from the spindle with Slide Hammer T50T-100-A and

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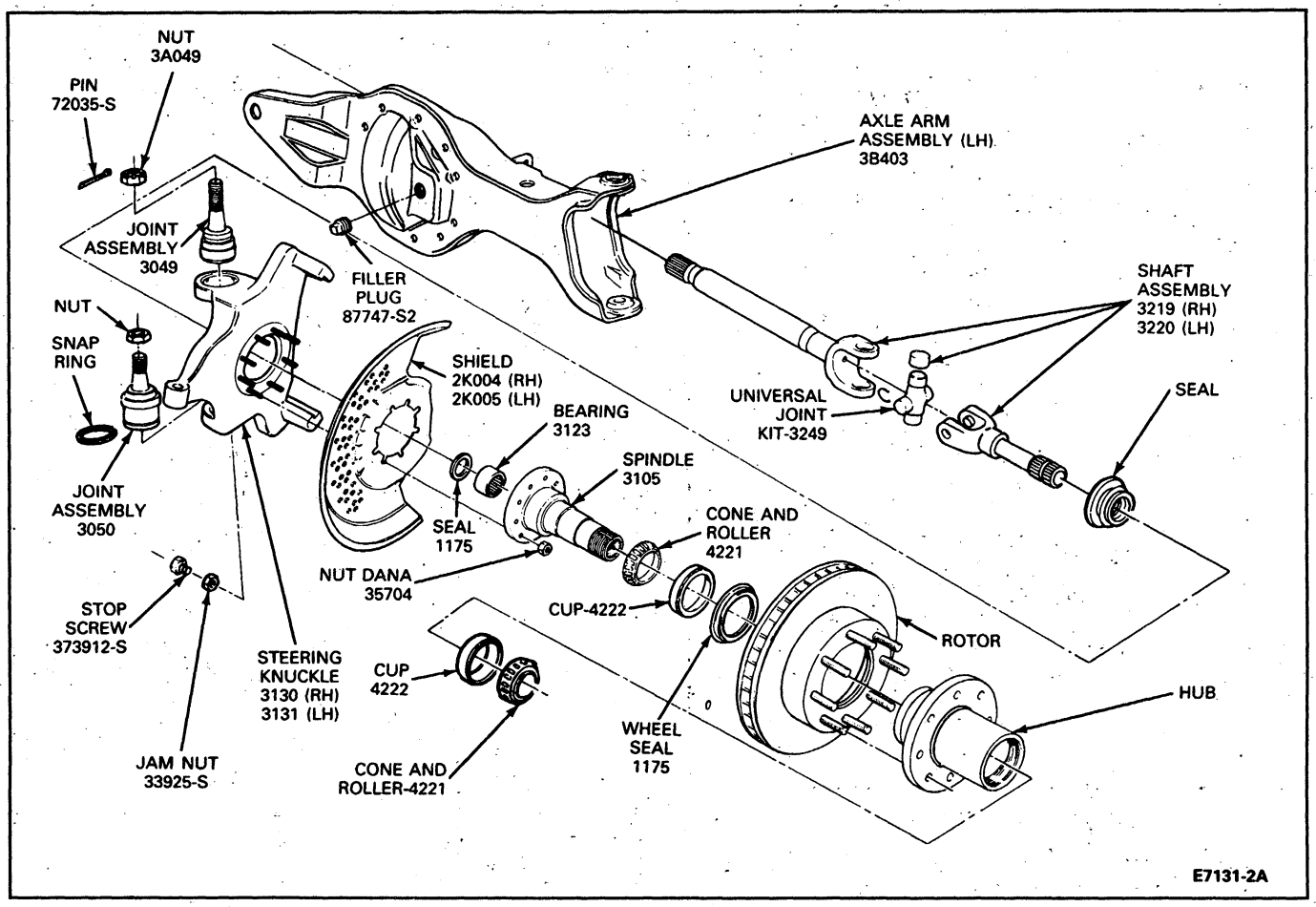


FIG. 13 Spindle and Left Shaft and Joint Installation—Typical

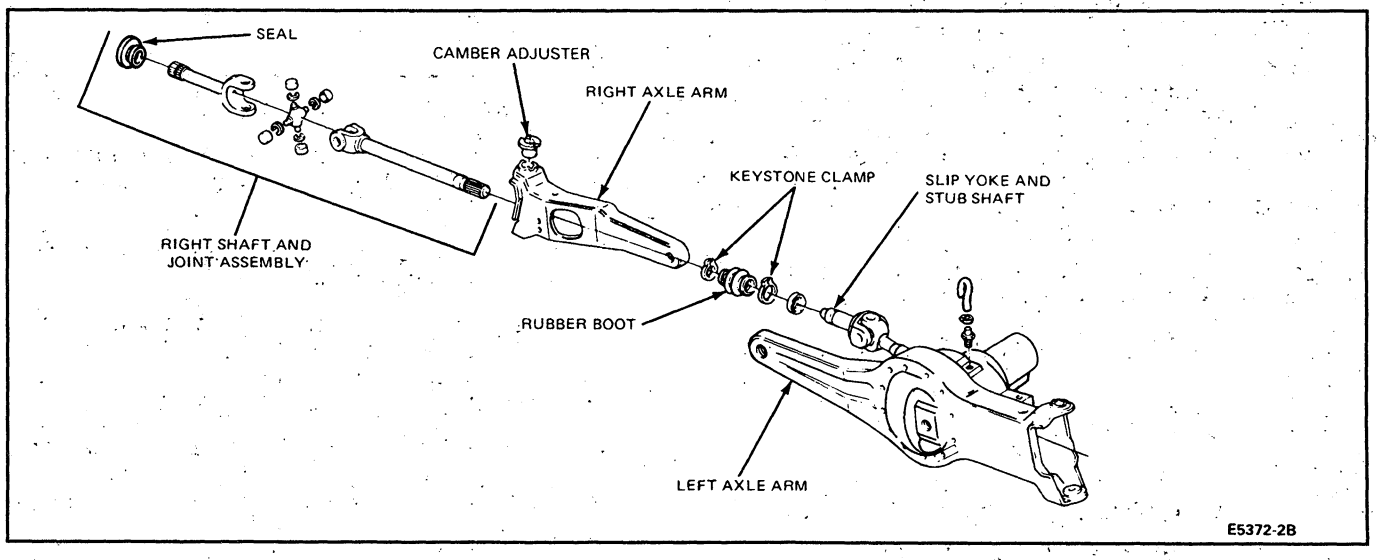


FIG. 14 Right Hand Shaft and Joint Assembly Installation—Typical

Bearing Cup Puller, T77F-1102-A or their equivalents (Fig. 17).

11. Inspect the sealing surfaces of the spindle for severely corroded, pitted, worn or galled sealing surfaces. Replace spindle if damaged. Refer to Figure 18.
12. Inspect the outer shaft of the axle shaft assembly for corroded, pitted, worn or galled surfaces in the inner oil seal and/or needle bearing areas. If damage to this area is evident, replace the outer shaft. Repair axle shaft as follows: Refer to Section 15-66, Driveshaft, Single Snap Ring Type U-Joint.

Installation

1. Clean all dirt and grease from the spindle bearing bore. Bearing bores must be free from nicks and burrs.

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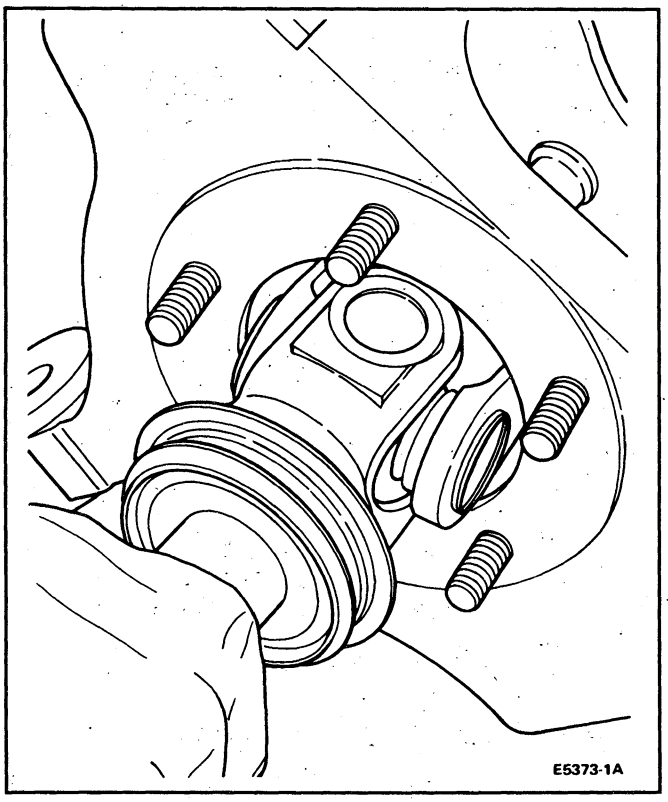


FIG. 15 Right Shaft and Joint Removal

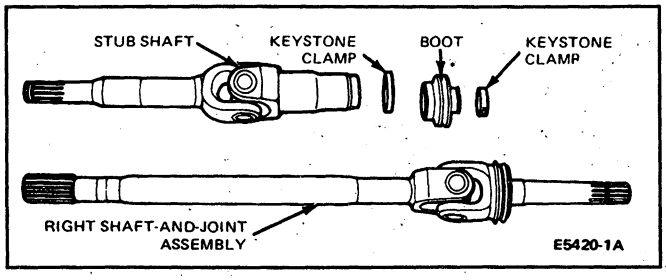


FIG. 16 Right Shaft and Joint—Exploded View

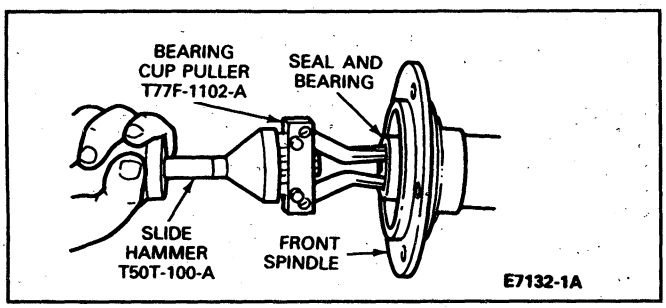


FIG. 17 Spindle Seal and Bearing Removal

2. Install a new needle bearing with writing facing outward in the spindle bore with Spindle Bearing Replacer, T80T-4000-R (or equivalent) on the F-350 or T80T-4000-S (or equivalent) for F-150—F-250 and Bronco, and Driver Handle T80T-4000-W (Fig. 19). Install a new needle bearing seal with the seal lip directed away from the spindle. Pack bearing and hub seal with grease. Install seal with Seal Replacer T80T-4000-T, and Driver Handle T80T-4000-W, or their equivalents (Fig. 20).

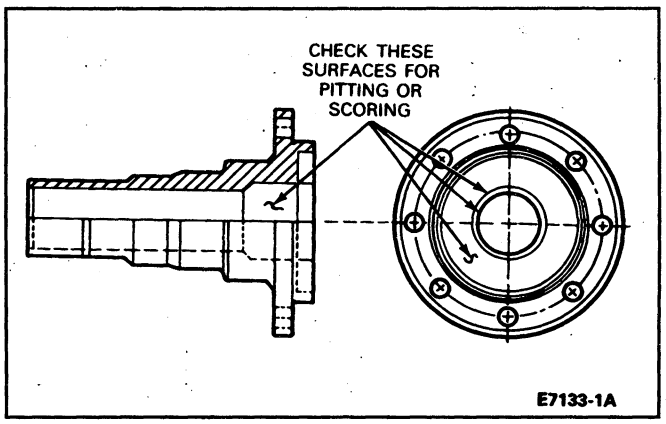


FIG. 18 Spindle Inspection Areas

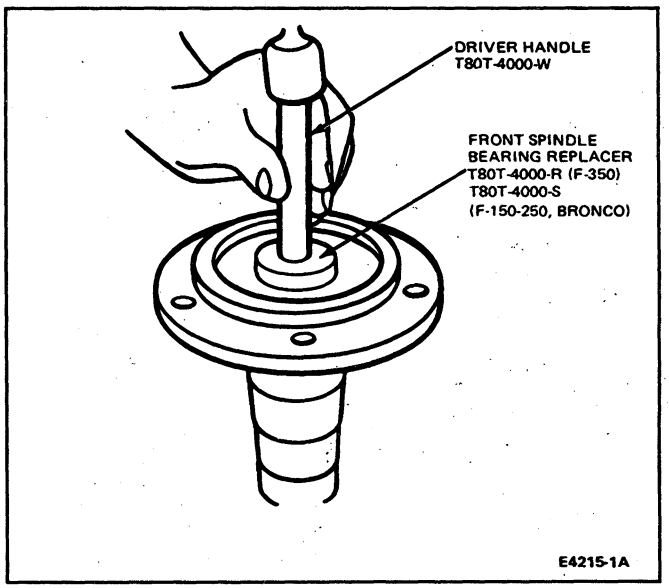


FIG. 19 Spindle Needle Bearing Installation

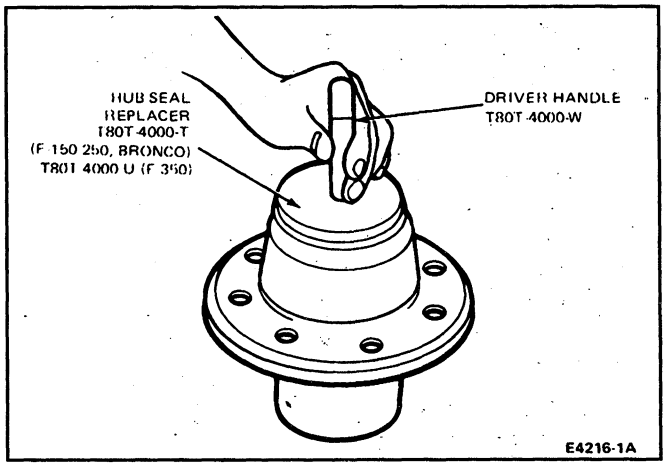


FIG. 20 Hub Seal Installation

3. Remove and install the seal on top of the needle bearing. Apply coating of grease to leading edge of seal lip. Place the thrust washer on the axle shaft.

4. Press a new slinger on the axle shaft with an appropriate piece of press stock. Refer to Fig. 21.

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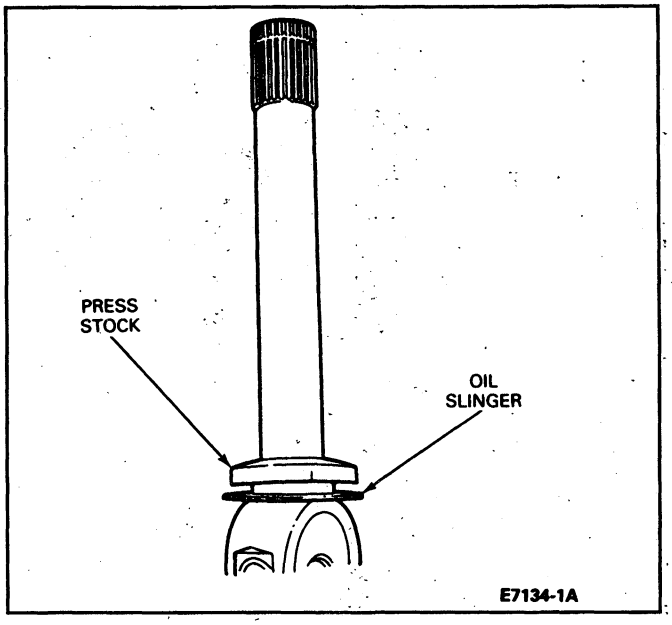


FIG. 21 Oil Slinger Installation

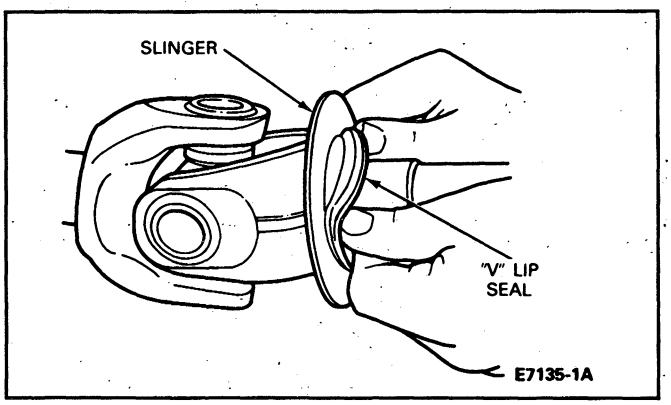


FIG. 22 V-Seal Installation

5. Install the rubber V-seal on the slinger and axle shaft. The lip of the seal should face towards the spindle. Refer to Figure 22.
6. Install the plastic spacer on the axle shaft. The chamferred side of the spacer should be inboard against the axle shaft. Refer to Figure 23.
7. Pack the thrust face of the seal in the spindle bore and the V-seal on the axle shaft with Long Life Lubricant (C1AZ-19590-BA) ESA-M1C75-B or equivalent. Refer to Figure 24.
8. On the right side of the carrier, install the rubber boot and new keystone clamps on the stub shaft slip yoke. Since the splines on the shaft are phased, there is only one way to assemble the right shaft and joint assembly into the slip yoke. Align the missing spline in the slip yoke barrel with the gapless male spline on the shaft and joint assembly. Slide the right shaft and joint assembly into the slip yoke making sure the splines are fully engaged. Slide the boot over the assembly and crimp the keystone clamp using Keystone Clamp Pliers, T63P-9171-A, or equivalent.
9. On the left side of the carrier slide the shaft and joint assembly through the knuckle and engage the splines on the shaft in the carrier.

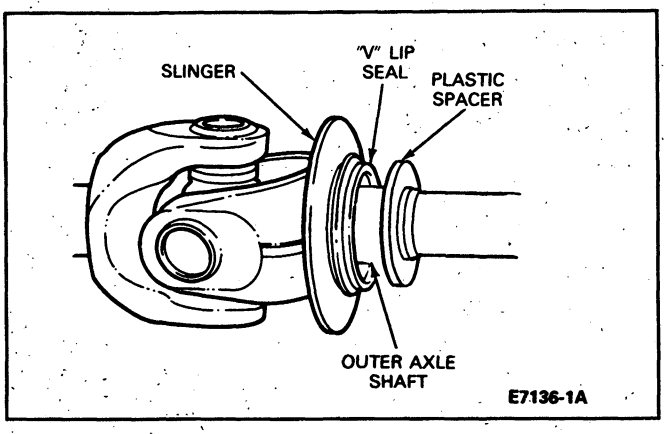


FIG. 23 Spacer Installation

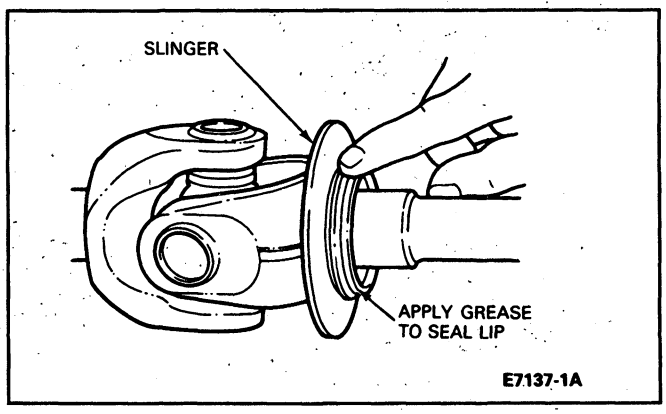


FIG. 24 V-Seal Lubrication

10. Install the splash shield and spindle onto the steering knuckle. Install and tighten the spindle nuts to 68-81 N·m (50-60 ft-lb).
11. Install the rotor on the spindle. Install the outer wheel bearing into the cup.

NOTE: Verify that the grease seal lip totally encircles the spindle.

12. Install the wheel bearing, locknut, thrust bearing, snap ring, and locking hubs per Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive.
13. Install the disc brake caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

Right Hand Slip Yoke and Stub Shaft Assembly, Carrier, Carrier Oil Seal, and Bearing

Refer to Fig. 25.

Removal

1. Remove the nuts and U-bolts connecting the driveshaft to the yoke. Disconnect the driveshaft from the yoke. Wire the driveshaft out of the way, so it will not interfere in the carrier removal process.
2. Remove both spindles and the Left and Right Shaft and U-joint assemblies as described in the Removal and Installation portion of this Section under Spindle and Left and Right Shaft and U-Joint Assemblies.

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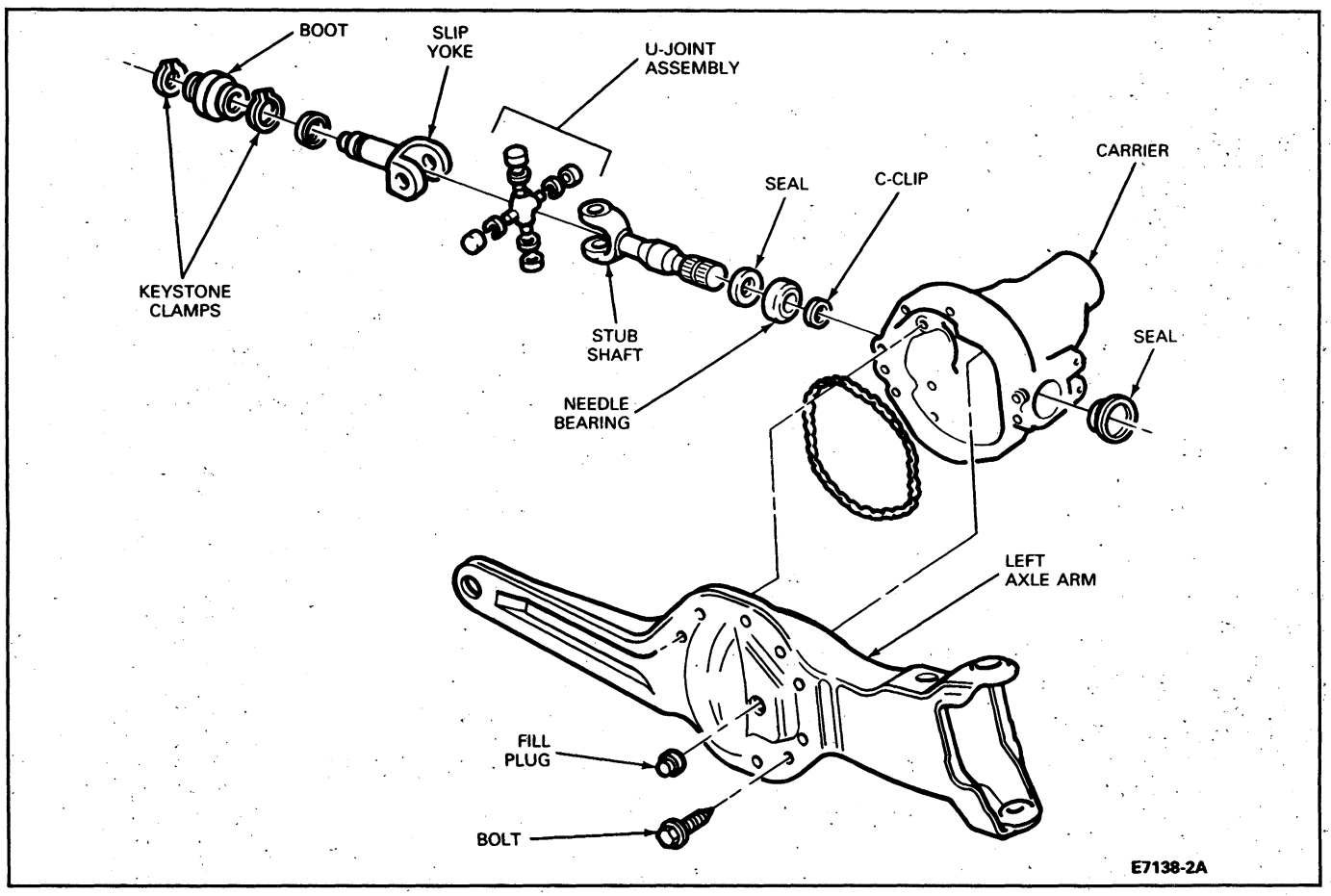


FIG. 25 Carrier and Slip Yoke and Stub Shaft Installation

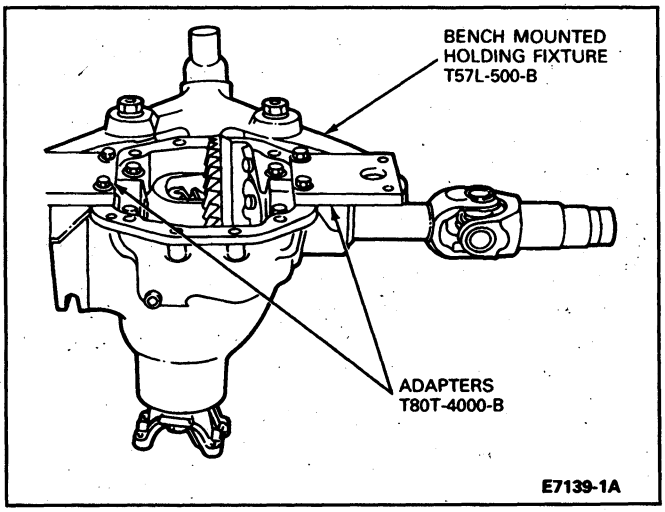


FIG. 26 Installing Carrier in Holding Fixture

3. Support the carrier with a suitable jack and remove the bolts retaining the carrier to the support arm. Separate the carrier from the support arm and drain the lubricant from the carrier. Remove the carrier from the vehicle.

4. Place the carrier in a Holding Fixture, T57L-500-B and Adapters, T80T-4000-B or equivalent (Fig. 26).

5. Rotate the slip yoke and shaft assembly so the open side of the snap ring is exposed as shown in Fig. 27. Remove the snap ring from the shaft.

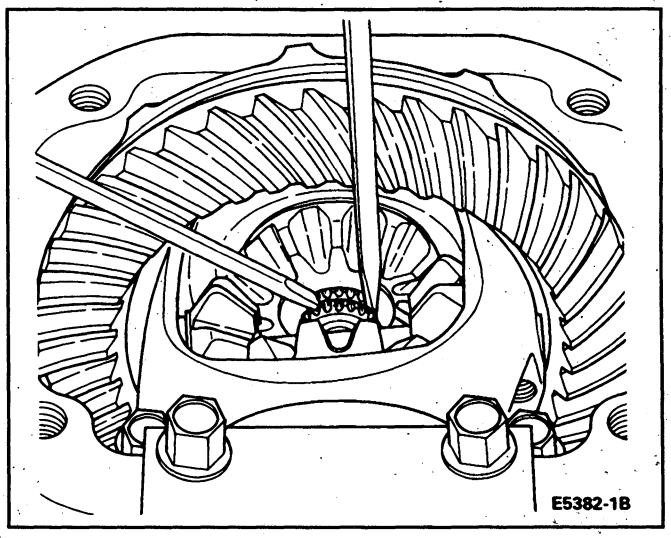


FIG. 27 Snap Ring Removal

6. Remove the slip yoke and shaft assembly from the carrier.

7. Remove the oil seal and caged needle bearings at the same time, using Slide Hammer, T50T-100-A and Collet, (part of Blind Hole Puller Set), D80L-100-A or equivalent as shown in Fig. 28. Discard the seal and needle bearing.

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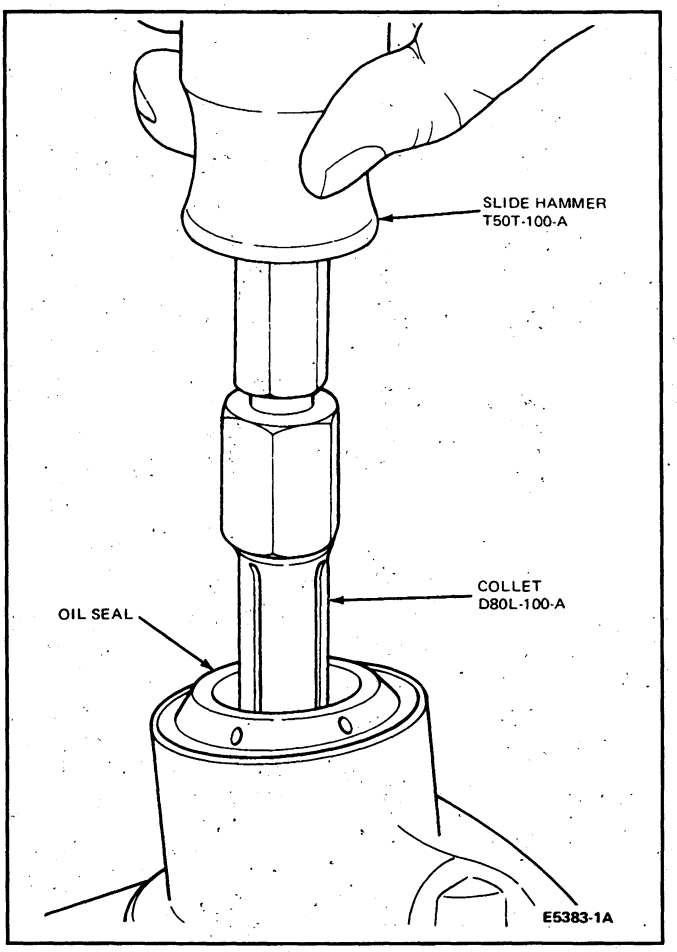


FIG. 28 Needle Bearing and Oil Seal Removal

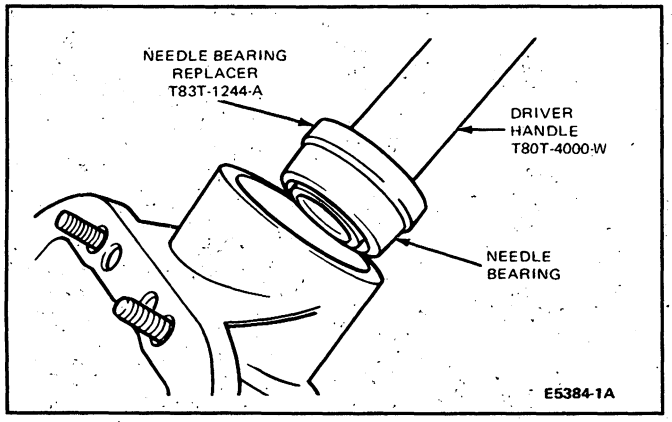


FIG. 29 Needle Bearing Installation

Installation

1. Make sure the bearing bore is free from nicks and burrs. Install a new caged needle bearing on Needle Bearing Replacer, T83T-1244-A or equivalent with the manufacturer name and part number facing outward towards the tool. Drive the needle bearing until it is seated in the bore (Fig. 29).

2. Coat the seal with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Drive the seal into the carrier using Needle Bearing Replacer T83T-1244-A or equivalent (Fig. 30).

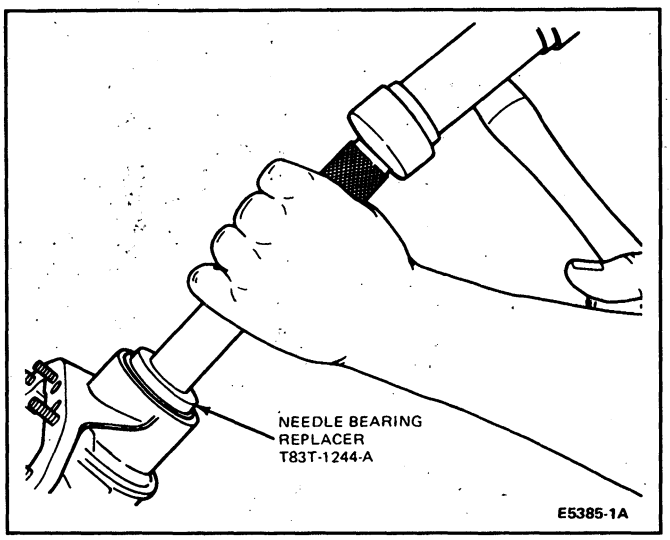


FIG. 30 Seal Installation

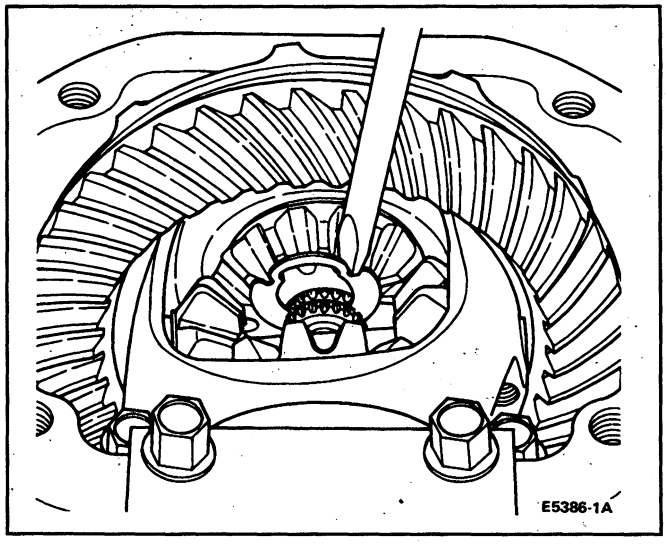


FIG. 31 Snap Ring Installation

3. Install the slip yoke and shaft assembly into the carrier so the groove in the shaft is visible in the differential case.

4. Install the snap ring in the groove in the shaft. Force the snap ring into position with a screwdriver as shown in Fig. 31. Remove the carrier from the holding fixture.

NOTE: Do not tap on the center of the snap ring. This may damage the snap ring.

5. Clean all traces of gasket RTV sealant from the surfaces of the carrier and support arm and make sure the surfaces are free from dirt and oil. Apply a bead of Silicone Rubber, D6AZ-19562-AA (clear) or -BA (black) (ESB-M4G92-A and ESE-M4G195-A) or equivalent, in a bead between 6.35-9.53mm (1/4-3/8 inch) wide. The bead should be continuous and should not pass through or outside the holes.

NOTE: The carrier must be installed on the support arm within five minutes after applying the RTV sealant.

6. Position the carrier on a suitable jack and install it in position on the support arm using guide pins to align it. Install the attaching bolts and hand tighten.

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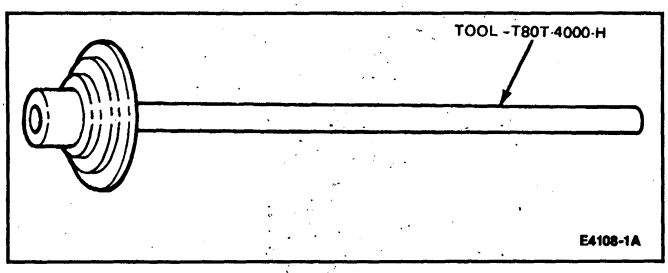


FIG. 32 Inner Axle Seal Installation Tool

Tighten the bolts in a clockwise or counter-clockwise pattern to 41-54 N·m (30-40 ft-lb).

7. Install support arm tab bolts to side of carrier and tighten to 115-136 N·m (85-100 ft-lbs).
8. Install both spindles and the left and right shaft and joint assemblies as described in the removal and installation portion of this Section.
9. Connect the driveshaft to the yoke. Install the nuts and U-bolts and tighten to 11-20 N·m (8-15 ft-lbs).

Left Differential Seal

Removal

1. Remove the spindle and left shaft assembly as described in this Section.
2. Pull out the seal with the appropriate Puller Tool T58L-101-B or equivalent. Remove and discard seal.

Installation

1. Install a new seal on the Differential Seal Replacer Tool T80T-4000-H or equivalent (Fig. 32).
2. Slide the seal and tool into the carrier housing bore. Seat the seal with a plastic or rawhide hammer.
3. Install the spindle and left shaft assembly as described in this Section.

Axle Shaft Bearing (IFS Front Drive Axle)

Removal

1. Remove the axle shaft assembly as described under Steering Knuckle Removal.
2. Remove screws from carrier to cover support arm. Drain lube by separating carrier assembly from support arm.
3. Place carrier assembly in a fixture. Rotate axle shaft so that open side of snap ring is exposed. Hold one side of snap ring firmly with a screwdriver, while pushing on other side. Remove snap ring.
4. Pull slip yoke/shaft assembly from unit.
5. Remove right hand trunnion axle shaft seal from housing. Pry seal out and discard. When removing a seal, be careful so as to avoid nicking or denting housing.
6. Remove the right hand trunnion axle shaft bearing.

NOTE: The bearing bore must be free from nicks and burrs. Clean bore out with standard metal cleaning solvent.

Installation

1. Install bearing assembly into bearing bore of right hand trunnion, with bearing name and part number facing outward towards installing Tool T80T-4000-N or equivalent. The tool will stop against housing when bearing is seated to proper depth.
2. Apply a light coat of grease on the lip of the seal and assembly into trunnion of the carrier.
3. Install slip yoke/shaft assembly into carrier and through side gear spline exposing snap ring groove inside differential.
4. Place the snap ring in the groove. Force the snap ring into place using two screwdrivers or other suitable tools.
5. Hold shaft and joint assembly in a heavy duty vise. Install a new spindle seal on outboard yoke shaft.

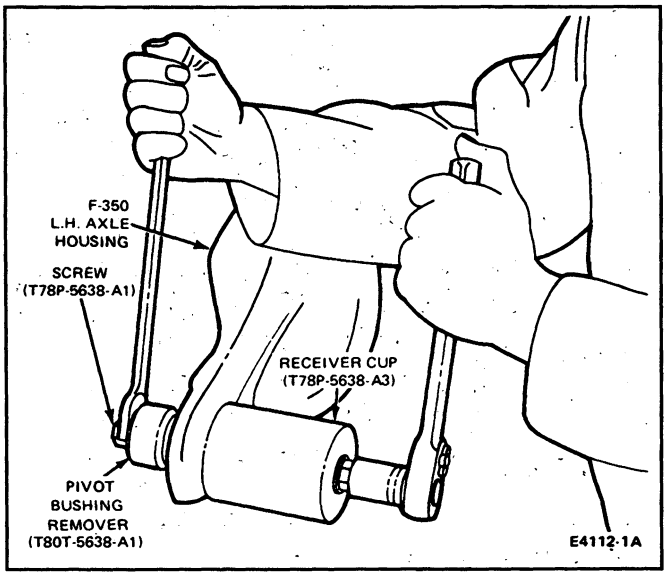


FIG. 33 Removing Axle Pivot Bushing

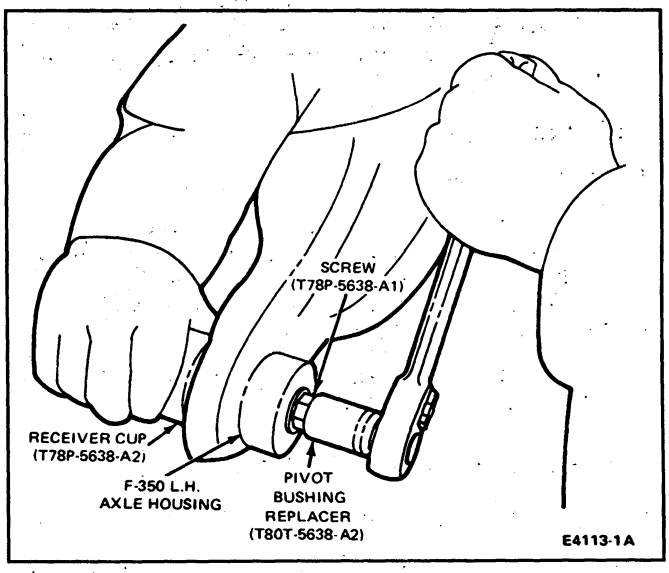


FIG. 34 Installing Axle Pivot Bushing

Axle Housing Pivot Bushing (IFS Front Drive Axle)

Removal

Refer to Fig. 33.

1. Remove axle as described in this Section under Front Drive Axle Removal and Installation.

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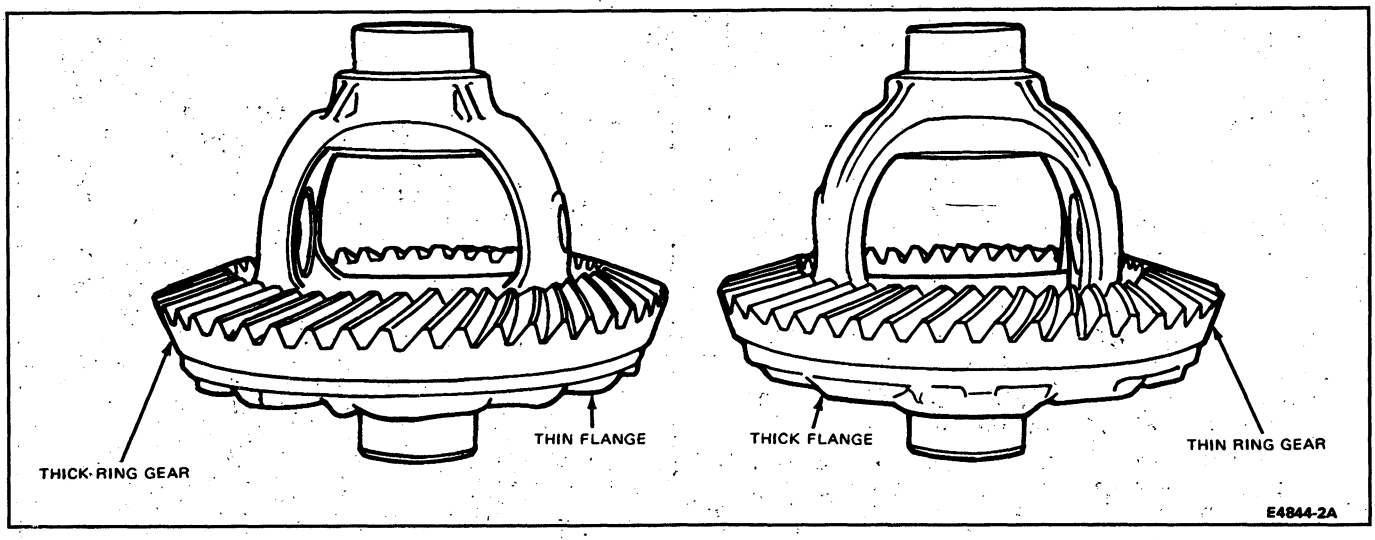


Fig. 35 Differential Cases and Ring Gear

2. Install Forcing Screw (T78P-5638-A1), Bushing Remover (T80T-5638-A1) and Receiver Cup (T78P-5638-A3), or equivalent onto the pivot bushing. Turn the forcing screw and remove the pivot bushing.

Installation

Refer to Fig. 34.

1. Place pivot bushing in axle housing. Install Receiver Cup, (T78P-5638-A2), Forcing Screw (T78P-5638-A1) and Bushing Replacer (T80T-5638-A2), or equivalent into housing and install bushing.
2. Install the axle as described in this Section under Front Driving Axle-Installation.

DISASSEMBLY AND ASSEMBLY

Cardan Type U-Joints

For disassembly and assembly procedures for cardan-type U-joints refer to Section 15-66, Driveshaft Single Snap Ring Type U-Joint.

Carrier

NOTE: When changing ratios on the 44 Series front drive axle, it may be necessary to change the differential case along with the ring gear and drive pinion. Ratios 2.72 to 1 up to 3.73 to 1 incorporate a thick differential case flange and a thin ring gear (Fig. 35). Ratios 3.92 to 1 up to 4.09 to 1 incorporate a thin differential case flange and a thick ring gear (Fig. 35).

Disassembly

1. Remove the left hand axle arm assembly as described in this Section under Removal and Installation.
2. Loosen the bolts retaining the carrier to the axle arm and drain lubricant. Remove the bolts retaining the support arm to the carrier and remove the carrier.
3. Place the carrier in a holding fixture, remove and clean all gasket surfaces and remove the bearing caps (Fig. 36). Note the matched numbers or letters stamped on the cap and carrier. These numbers or letters must be matched upon assembly.

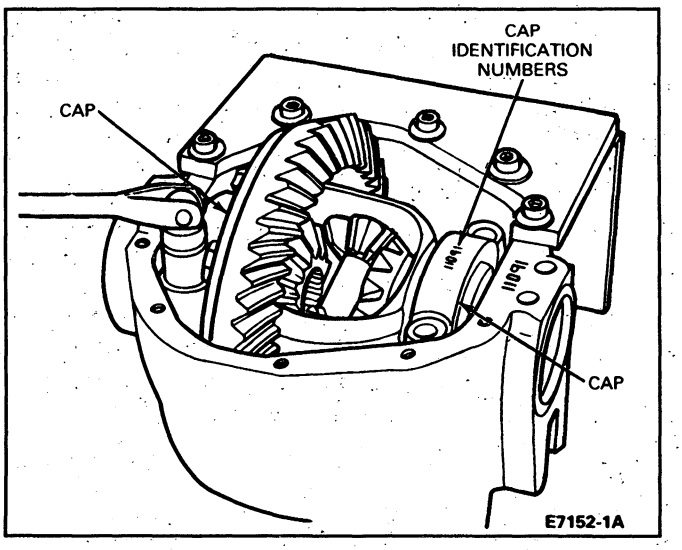


FIG. 36 Removing Bearing Caps

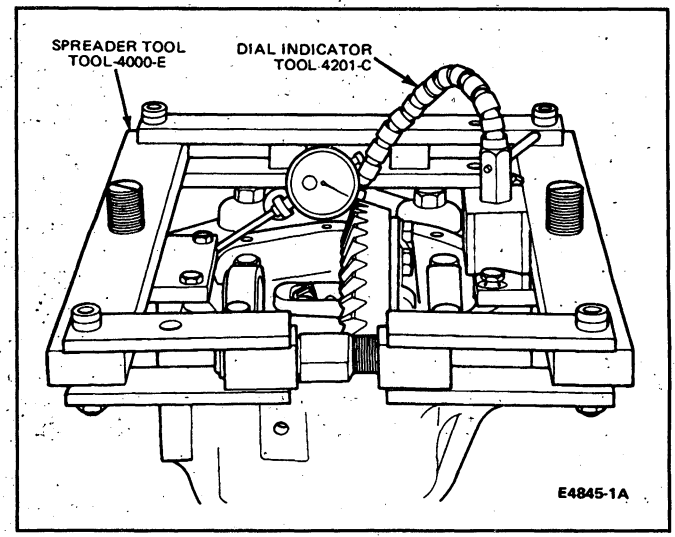


FIG. 37 Installing Spreader

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4. Mount Spreader Tool-4000-E and Spreader Adapter T80T-4000-B on carrier. Place a dial indicator, TOOL-4201-C or equivalent, on the carrier and spread the housing (Fig. 37). **Do not spread the carrier over 0.25mm (0.010 inch).**
5. Remove the differential case from the carrier. It may be necessary to pry the case from the carrier with pry bars. Use caution to avoid damaging any machined surfaces. Remove and tag bearing cups to indicate from which side of the carrier they were removed. Remove the spreader tool.
6. Turn the nose of the carrier up. Hold the end yoke with Holding Tool T78P-4851-A or equivalent and remove the pinion nut and washer from the pinion shaft.
7. Remove the end yoke with T65L-4851-B, Yoke Remover. If the yoke shows any signs of wear in the area of seal contact, replace the yoke.
8. Remove the drive pinion by tapping on the drive pinion shaft with a rawhide or plastic hammer. Catch the pinion to prevent damage to the pinion.

   CAUTION: Be careful not to damage the pinion bearing preload shims located on the splined end of the pinion. If damaged, replace with shims of equal thickness. Do not lose the shims.

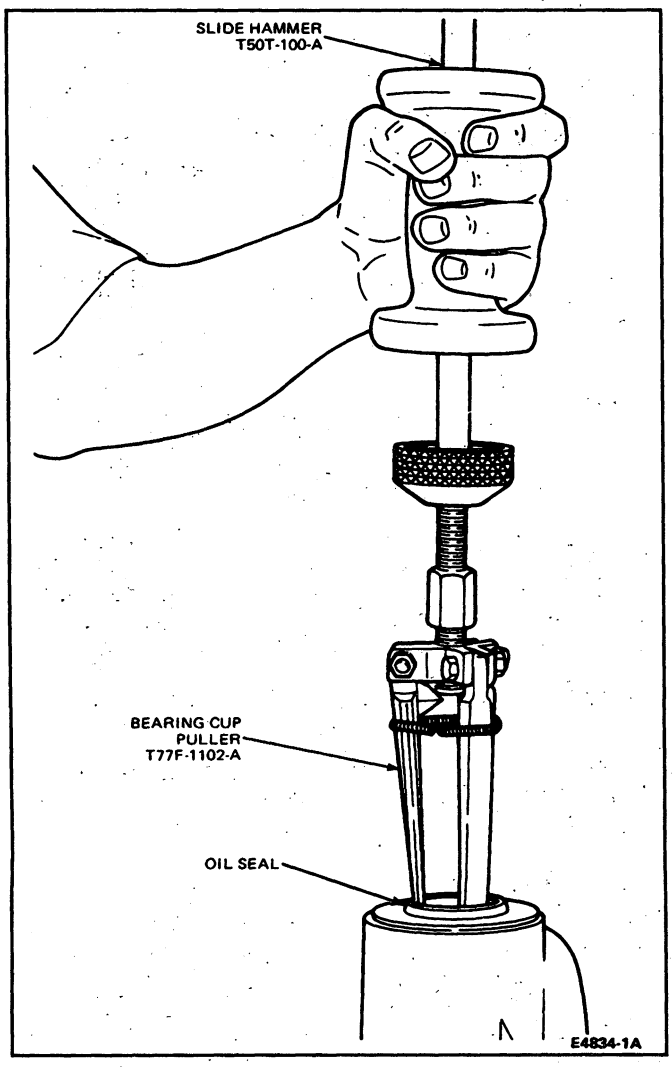


FIG. 38 Oil Seal Removal

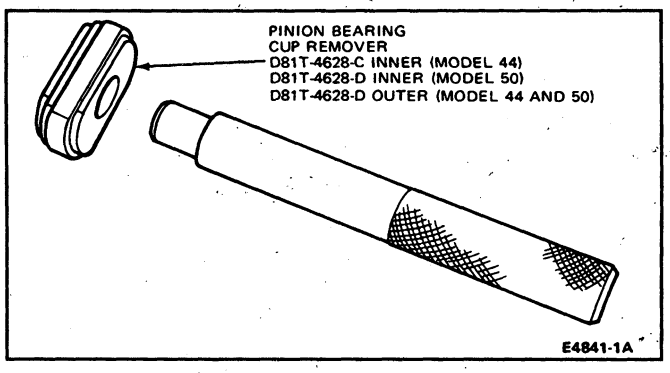


FIG. 39 Bearing Cup Removal

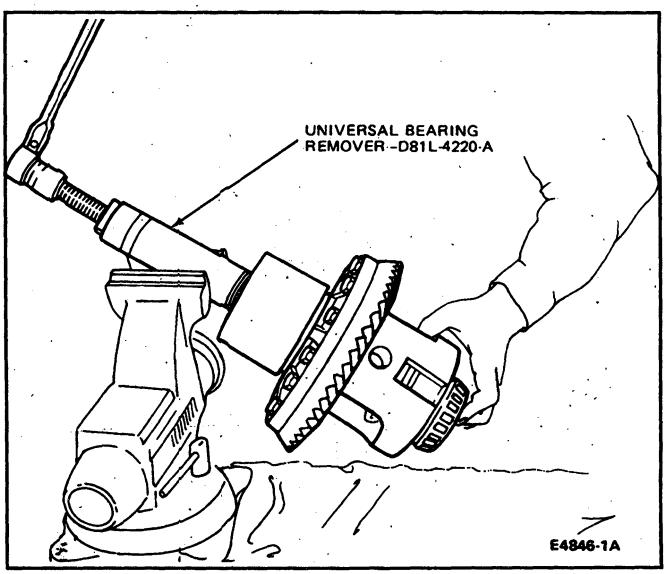


FIG. 40 Differential Side Bearing Removal

9. Remove the drive pinion oil seal from the carrier bore by using Bearing Cup Puller, T77F-1102-A, and Slide Hammer, T50T-100-A or equivalent (Fig. 38). Replace the oil seal with a new seal during assembly.
10. Remove the outer pinion bearing and the oil slinger from the carrier input bore.

    Remove the pinion bearing preload shims. Make sure all shims are removed from the carrier. Replace any damaged shims. Shims are available in thicknesses of 0.08, 0.13, 0.25 and 0.76mm (0.003, 0.005, 0.010 and 0.030 inch).
11. Remove the inner pinion bearing cup and baffle using Pinion Bearing Cup Remover, D81T-4628-C (Model 44 axles) or D81T-4628-D (Model 50 axles) and Driver Handle, D81L-4000-A or equivalent (Fig. 39). Drive the bearing cup out of the bore.

    NOTE: Oil baffle and shims are located between the inner bearing cup and carrier bore. Be careful not to damage the shims when removing the bearing cup. If any shims are damaged, measure the thickness and replace with shims of equal thickness.
12. Turn the nose of the carrier down and remove the outer pinion bearing cup. Drive the cup from the carrier using Pinion Bearing Cup Remover D81T-4628-D (Model 44 and 50 axles) and Driver Handle D81L-4000-A or equivalent (Fig. 39).

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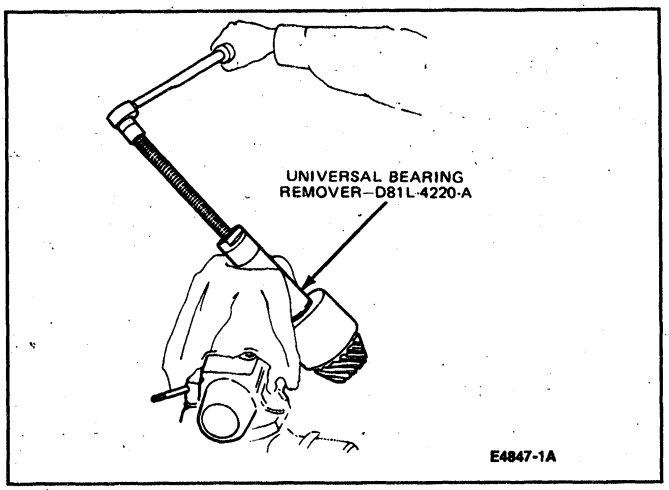


FIG. 41 Drive Pinion Bearing Removal

13. Remove the differential case bearings and shims from the case. Place Step Plate, D80L-630-5 or equivalent under bearing to protect the bearing. Install Universal Bearing Remover, D81L-4220-A (or equivalent) and remove the bearing as shown in Fig. 40. Turn the case over and remove the other bearing.
14. Wire the shims, bearing cup and cone together and identify from which side of the differential case they were removed. If any shims are damaged, replace with new shims upon assembly.
15. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked, after it is free from the case. Place the case in a vise. Remove the ring gear bolts. Tap the ring gear with a rawhide hammer to free it from the case. Remove the case and ring gear from the vise.

    NOTE: Whenever removing the ring gear bolts, discard the bolts and replace with new bolts upon assembly.
16. Remove the bearing and oil slinger from the drive pinion with Universal Bearing Remover, D81L-4220-A or equivalent (Fig. 41).
17. Inspect all parts for damage and replace as required.

Total Differential Case Endplay

Assembly

1. Attach the ring gear to the differential case using new bolts. Tighten bolts alternately and evenly to 68-81 N·m (50-60 ft-lbs).
2. Clean the trunnions on the differential and install the Master Differential Bearings D81T-4222-B for Model 44 axles or D81T-4222-C or their equivalents for Model 50 axles (Fig. 42) onto the differential case. Remove all burrs and nicks from hubs so master bearings rotate freely.
3. Place the differential case into carrier (without pinion). The differential case should move freely in the carrier. Mount dial indicator (D78P-4201-B or Tool-4201-C, or equivalent) against the differential case flange as shown in Fig. 43. Locate the tip of the indicator on the flat surface of one ring gear bolt. Force the differential case toward the dial indicator as far as possible and zero the dial indicator with force still applied.

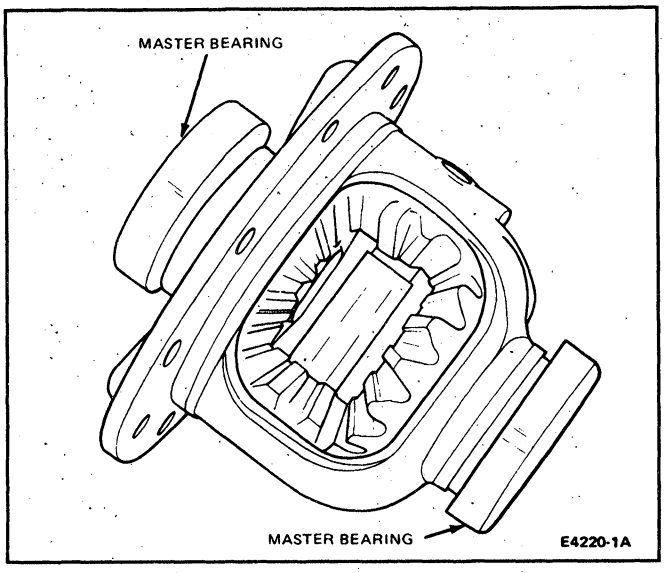


FIG. 42 Master Bearing Installation

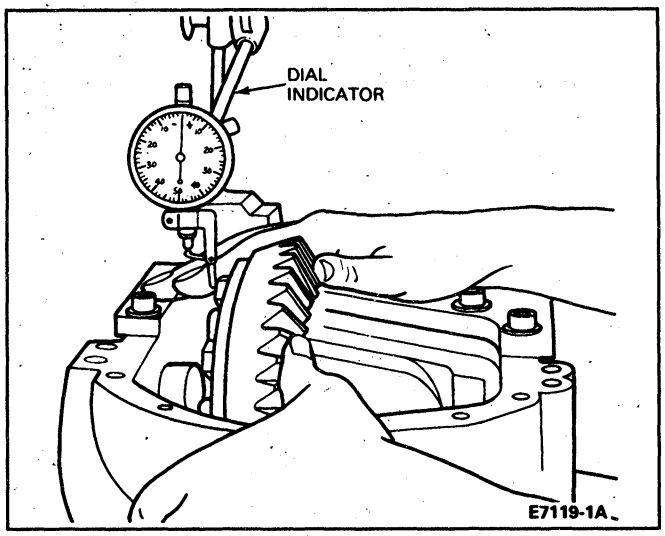


FIG. 43 Checking Differential Case Endplay

NOTE: Dial indicator should have a minimum travel capability of 5.08mm (0.200 inch).

4. Force the differential case away from the dial indicator as far as it will go. Repeat this procedure until the same reading is obtained. Record the dial indicator reading. This reading indicates the amount of shims needed behind the differential side bearings to take up total clearance between the differential bearing and case. This reading will be used under Pinion and Ring Gear Backlash.
5. Remove the differential case from the carrier. Do not remove the master differential bearings at this time.

Drive Pinion Installation

Two separate adjustments affect drive pinion and ring gear tooth contact. They are pinion depth (location) and backlash. The pinion locating shim pack is installed between the drive pinion inner bearing cup and carrier housing (Fig. 44). This shim pack and inner oil slinger and oil baffle controls the position of the pinion. Adding shims moves the pinion toward the ring gear and

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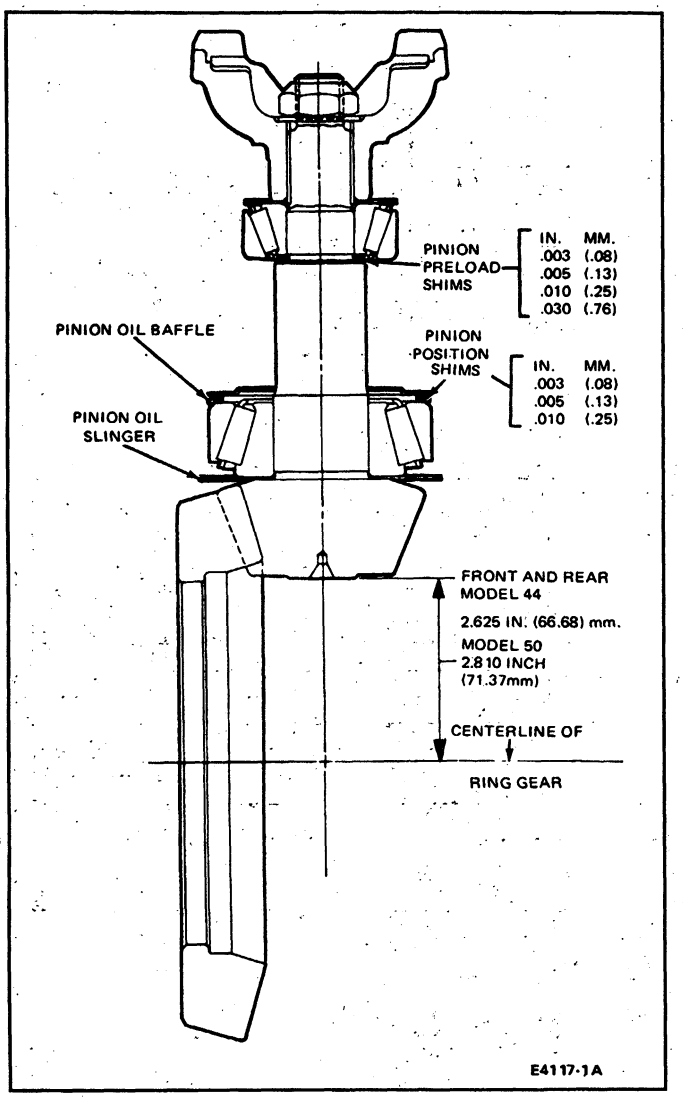


FIG. 44 Ring Gear and Tooth Contact

removing shims moves the pinion away from the ring gear.

Ring gears and pinions are supplied in matched sets with standard or metric markings (Fig. 45).

On the face of each drive pinion is marked a plus figure (+), a minus figure (-) or a zero (0). These figures indicate the position for each gear set. The position is determined by the amount of shims between the inner pinion bearing cup and carrier bearing bore. Refer to the charts in Figs. 46 and 47.

For example, if a new pinion is marked 'positive' +3 (+8-metric) and an old pinion is marked 'O', shims measuring (0.003 inch) 0.08mm must be removed between the drive pinion and inner bearing cup and retainer.

If the old ring and pinion shim pack is used, measure the slinger and baffle and each shim separately and add each shim measurement to total the original measurement. Replace the old shims with new shims that equal this measurement.

If a new ring and pinion is being installed, note the plus (+), minus (-) or zero (0) marking on the button of the pinion. Refer to the chart in Fig. 46 or Fig. 47. Add or subtract shims, according to the chart to compensate for differences between the old and new pinion.

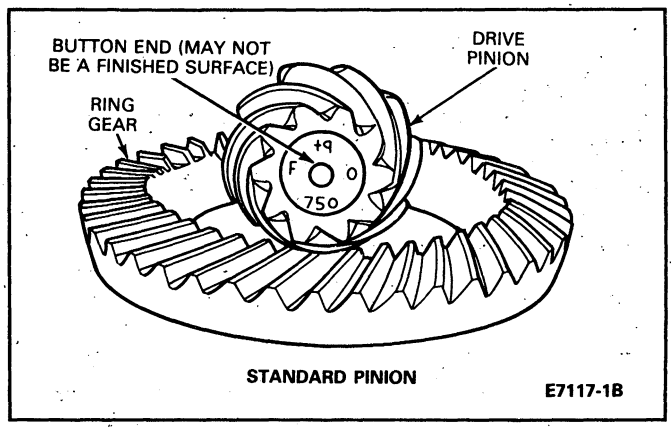


FIG. 45 Ring Gear and Drive Pinion—Standard and Metric

A new ring gear and drive pinion is always installed as a matched set and never separately. **Be sure that the same matching number appears on both the drive pinion and ring gear.**

Install the correct shim pack of the drive pinion and place the pinion in the carrier. Check pinion depth.

Depth Gauge Check

1. Refer to Fig. 48 for the correct tools for the particular axles.

   NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure no erroneous readings.

2. Install inner and outer pinion cups with Forcing Screw T75T-1176-A and Pinion Bearing Cup Replacers, T80T-4000-D, (inner cup) and T80T-4000-E (outer cup) or equivalents (Fig. 51).

3. Place a new rear pinion bearing over the proper aligning adapter and insert into the pinion bearing retainer assembly. Place the front pinion bearing (new or used if in good condition) into the bearing cup in the carrier and assemble the handle onto the screw and hand tighten. Note the 3/8 inch square drive in the handle to be used for obtaining the proper pinion bearing preload.

4. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten to proper specifications. To preload the bearing, tighten the handle to 2.3-4.5 N·m (20-40 in-lbs).

5. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge or shims directly along the gauge block to insure a correct reading. The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling.

6. After the correct shims or feeler gauge feel is obtained, check the reading and this is the thickness of shim(s) required providing that upon inspection of the service pinion gear, the button is etched "0".

   NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in step 5 (Example: +2 (-0.002)).

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Old Pinion Marking	New Pinion Marking								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

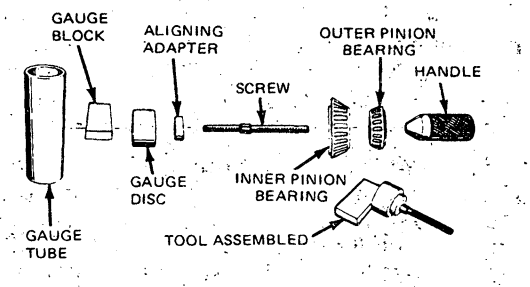
E4091-2A

FIG. 46 Shim Adjustment for Pinion Replacement—Standard

Old Pinion Marking	New Pinion Marking								
	−10	−8	−5	−3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05
+3	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08
0	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10
−3	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13
−5	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15
−8	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18
−10	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18	−.20

E4092-2A

FIG. 47 Shim Adjustment for Pinion Replacement—Metric



Tool	Tool Number	Axle Model 44	Axle Model 50
Aligning Adapter	T75P-4020-A2	X	X
Gauge Disc	T80T-4020-F40		X
	D80T-4020-F44	X	
Gauge Block	T80T-4020-F42	X	X
Screw	T80T-4020-F43	X	X
Handle	T76P-4020-A11	X	X
Gauge Tube	T80T-4020-F41		X
	D80T-4020-F47	X	

E4118-1B

FIG. 48 Depth Gauge Tool Selection

If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in step 5 (Example: —2 (+0.002)).

In addition you must use the exact same new rear pinion bearing that was used in the previous steps.

7. Measure shims with a micrometer to verify the shim size. Place the oil slinger (if used) (Fig. 49) on the pinion and press on the bearing. Use T53T-4621-B, Pinion Bearing Cone Replacer for Model 44 Axles and T75L-1165-B, Axle Bearing/Seal Plate (or equivalent tools) as shown in Fig. 50.

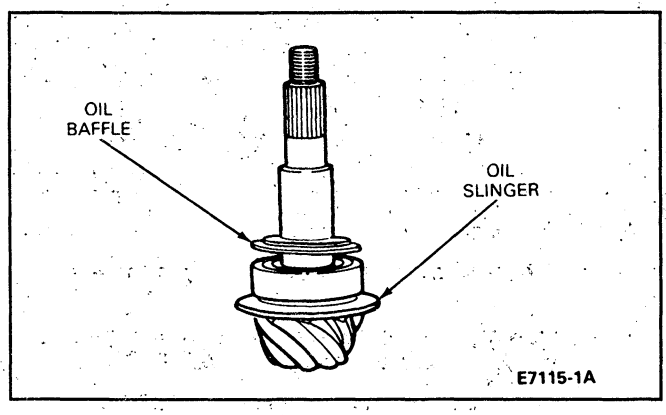


FIG. 49 Baffle and Oil Slinger Positions

NOTE: If a baffle and/or slinger is used, replace with a new one upon assembly and measure as part of the shim stack.

8. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

Bearing Cup and Drive Pinion Installation

1. Clean the bore, and if installed, remove the cup. Place the oil baffle first and the required amount of shims in the inner pinion bearing bore and drive the inner pinion bearing cup in place with special Tool T80T-4000-D, Inner Pinion Bearing Cup Replacer (for Model 44 axles) or T80T-4000-F (for Model 50

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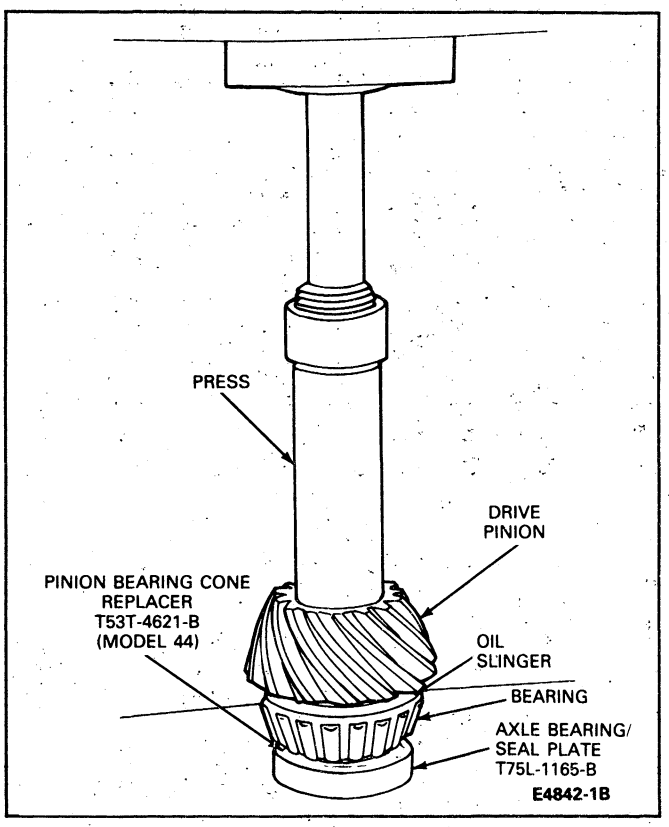


FIG. 50 Drive Pinion Bearing Installation

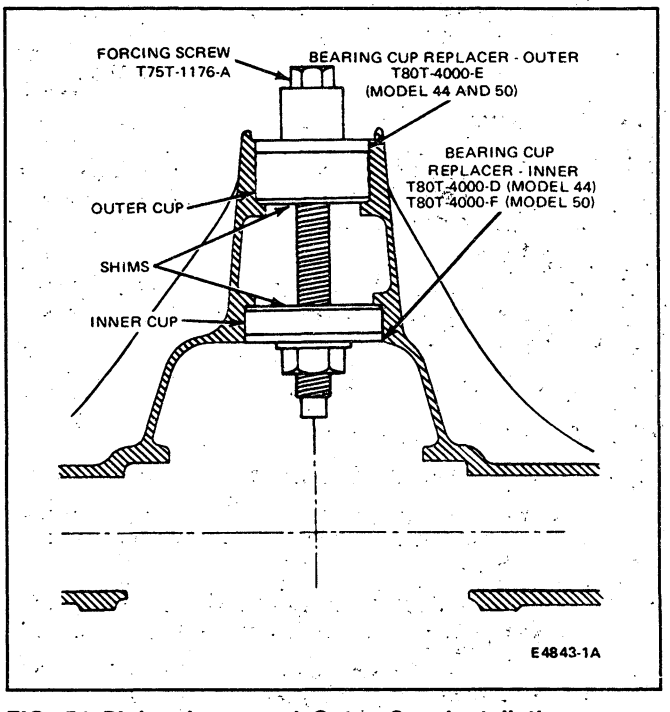


FIG. 51 Pinion Inner and Outer Cup Installation

axles) and Forcing Screw T75T-1176-A (or equivalents). Be careful not to cock the cup.

2. Place the outer pinion cup into the carrier and drive in place with special Tool T80T-4000-E or equivalent. For Model 44 and 50 axles Outer Pinion Cup Replacer, install Forcing Screw T75T-1176-A or equivalent and draw the cups into the bore (Fig. 51).

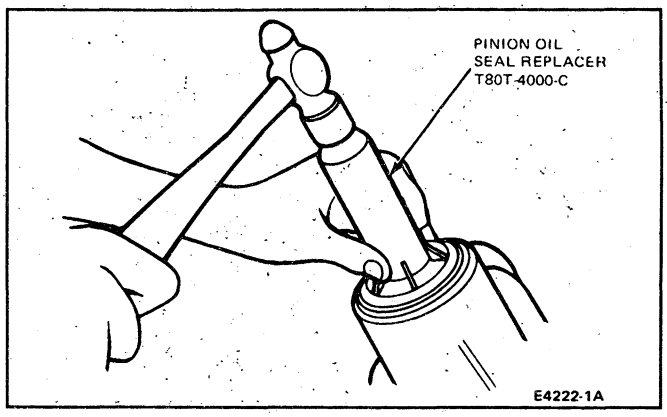


FIG. 52 Pinion Oil Seal Installation

3. Lubricate the ends of outer pinion bearings rollers with Long Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Install the outer bearing cone in place in outer bearing cup.
4. Install the inner bearing cone and slinger on the pinion. Drive the bearing on the pinion shaft until fully seated using T53T-4621-B (Model 44 axles) and Axle Bearing/Seal Plate, T75L-1165-B or equivalents as shown in Fig. 50.

Drive Pinion Preload Check

1. Measure original preload shims and replace with new shims of equal size.
2. Install the pinion into the carrier.
3. Install new preload shims over the pinion. Install the outer pinion bearing cone and oil slinger.
4. Assemble end yoke, washer, deflector, and slinger on pinion shaft and align with special Tool T83T-4851-A and T78P-4851-A, Companion Flange Holder (or equivalents) to seat the yoke (Fig. 53). Install a new pinion nut and tighten nut to 271-298 N·m (200-220 ft. lb).
5. Rotate pinion nut with an inch-pound torque wrench. Rotating torque should be 2.25-4.52 N·m (20-40 in-lbs). To increase preload, remove shims. To decrease preload, add shims.
6. Install the Gauge Tube, D80T-4020-F47 (for Model 44 axles) or T80T-4020-F41 or equivalents (for Model 50 axles). Install bearing caps and tighten to 108-122 N·m (80-90 ft-lbs).
7. With the drive pinion at the correct depth, remove the yoke with Holding Tool, T78P-4851-A and Yoke Remover, T65L-4851-B. Remove the yoke, nut and washer.
8. Coat the oil seal with Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent. Install the drive pinion oil seal with T80T-4000-C, Oil Seal Replacer (Fig. 52). After installation, make sure the garter spring didn't pop out. If the garter spring pops out, remove and replace the seal.
9. Install the yoke with Companion Flange Replacer, T83T-4851-A (Fig. 53). Install washer and nut and tighten nut to 271-298 N·m (200-220 ft-lbs).

Differential Case

Disassembly

1. Place differential case in vise and drive out lock pin that retains the pinion mate shaft to case (Fig. 54).

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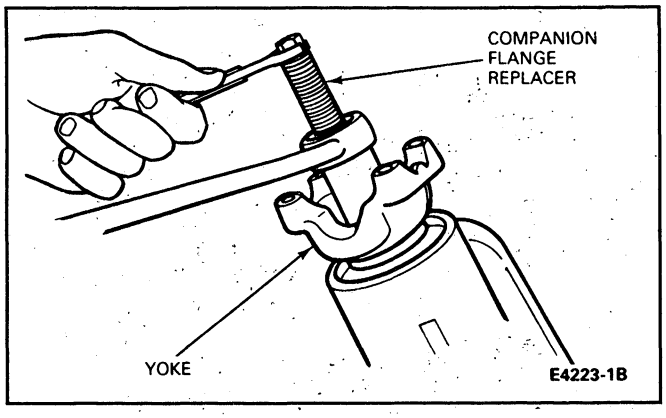


FIG. 53 End Yoke Installation

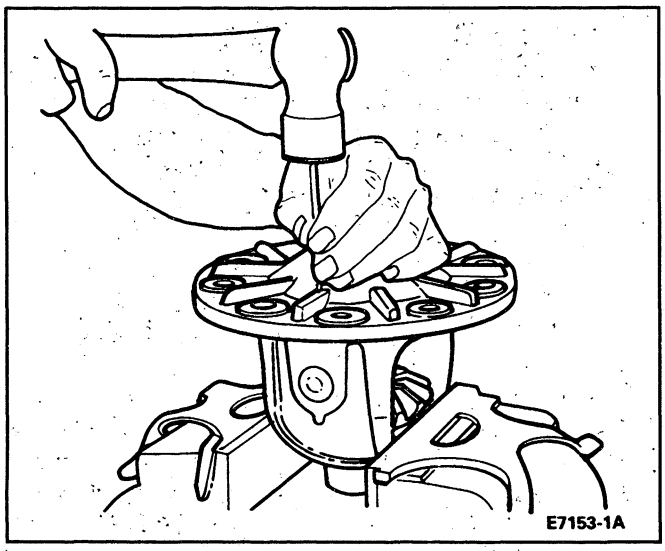


FIG. 54 Removing Lock Pin

2. Remove drive pinion mate shaft with a drift (Fig. 55).

3. Rotate the pinion mate gears and side gears until the pinion mate gears turn to the windows of the case. Remove pinion mate gears and spherical washers (Fig. 56).

4. Lift side gears and thrust washers from case.

Assembly

1. Inspect case parts for signs of wear. If wear exists on all parts, replace the entire differential case assembly. If one gear shows signs of wear, replace both pinion mate and side gears as a set.

2. Apply grease Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent to side gear thrust washers, hub and thrust face of side gears. Lubricate pinion mate gears and spherical washer with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75B) or equivalent.

3. Hold side gears in place in case with one hand and install pinion mate gears and spherical washers with other hand. Rotate the side gears and pinion mate gears until the holes in the washers and pinion mate gears line up exactly with the holes in the case.

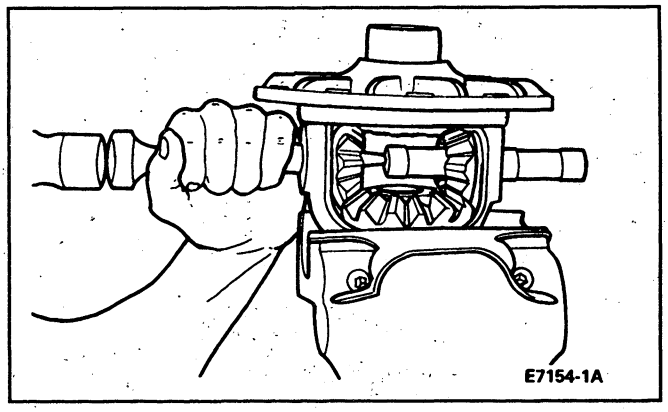


FIG. 55 Removing Mate Shaft

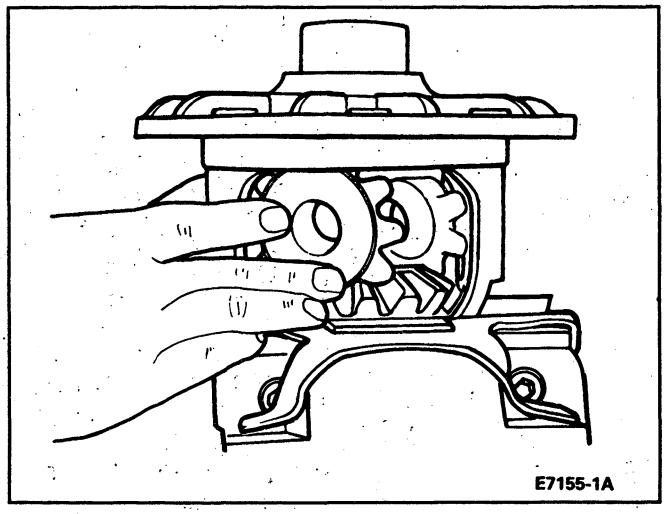


FIG. 56 Removing Pinion Mate Gears

4. Insert the pinion mate shaft in the case. Make sure the lock pin hole in the shaft lines up with the lock pin holes in the case.

5. Insert lock pin. Peen some metal of the case over the pin to lock it in two places 180 degrees apart. Note the location of the slot in the lock pin. Peen 90 degrees from slot.

Differential Case

Assembly to Carrier

Pinion and Ring Gear Backlash

1. Assemble ring gear to differential case. Use new bolts and tighten alternately and evenly to 61-81 N·m (45-60 ft. lb).

2. Place the differential case into position in the carrier. (Master bearings should still be installed.)

3. Force the differential case away from the drive pinion gear, until it is completely seated against the cross bore face of the carrier. Position a dial indicator so the indicator tip rests on a differential case bolt as shown in Fig. 43. Zero the dial indicator.

4. Force ring gear against pinion gear. Rock ring gear slightly to make sure gear teeth are in contact. Then, force ring gear away from drive pinion gear, making sure the dial indicator returns to zero. Repeat this procedure until the dial indicator reading is the same. This reading reveals the

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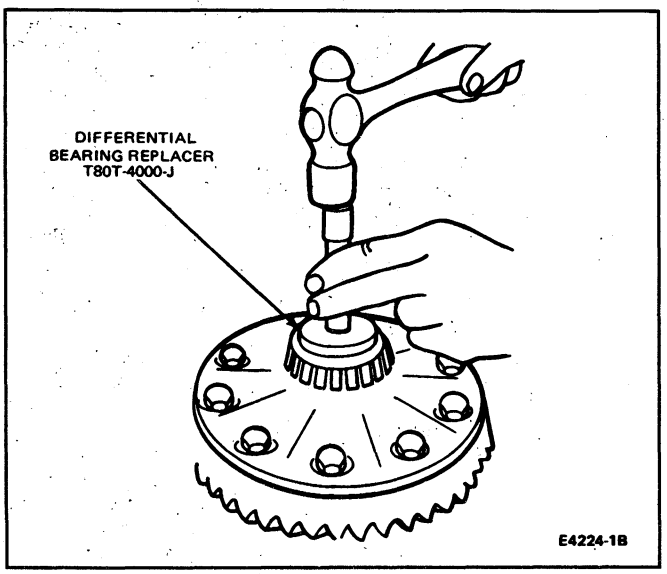


FIG. 57 Differential Side Bearing Installation

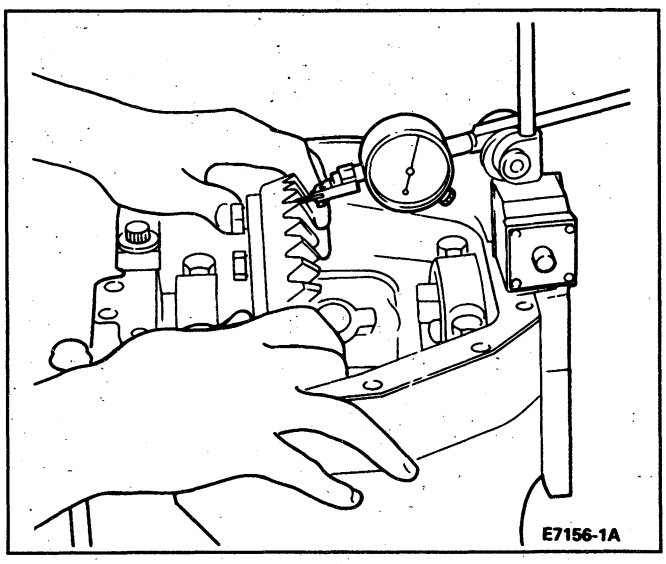


FIG. 58 Ring Gear and Backlash Check

amount of shims necessary between the differential case and differential bearing on the ring gear side.

5. Remove the differential case from the carrier and remove the master bearings from the case.
6. As determined in step 4, place the required amount of shims on the ring gear hub of the differential case. For example: If the reading in step 4 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.
7. Install the bearing cone on the hub of the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer, T80T-4000-J or equivalent as shown in Fig. 57.
8. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in step 4 from the Differential Total Case Endplay. Total Case Endplay was determined in steps 3 and 4 of Differential Total Case Endplay. When this amount is determined, add 0.26mm (0.010 inch) to the amount. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

   For example: Total Case Endplay was 2.30mm (0.091 inch). The reading in step 4 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch), 0.26mm (0.010 inch) is added to give 1.42mm (0.056 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.
9. Place the required amount of shims on the hub of the drive pinion side of the differential case.
10. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate, D80L-630-5 or equivalent on the ring gear side bearing to protect the bearing. Drive the bearing onto the hub of the drive pinion side of the differential case using Differential Side Bearing Replacer, T80T-4000-J (or equivalent).
11. Install bearing cone on the pinion side of the differential case with special Tools T80T-4000-J or equivalent, Differential Bearing Replacer (Fig. 57). Place the Pinion Bearing Cone Replacer, T53T-4621-C or equivalent, on the ring gear bearing to prevent damage.
12. Install the differential bearing cups on the bearing cones.
13. **With the spreader and dial indicator installed on the case, spread the carrier housing but do not exceed 0.25mm (0.015 inch).**
14. Install the differential case in the carrier. If necessary use a rawhide or plastic hammer to seat the differential case into the carrier housing cross bore. With partial and non-hunting/partial ring gear and pinion sets, align the marks on the ring gear and drive pinion. Be careful to not nick the teeth of the ring gear or pinion. Remove the spreader and dial indicator from the case.
15. Install bearing caps and bolts. Make sure the letters or numbers stamped on the caps correspond in both position and direction with the letters or numbers stamped into the carrier. Tighten bolts to 108-122 N·m (80-90 ft. lb).
16. Install dial indicator Tool 4201-C or equivalent on the case as shown in Fig. 58. Check ring gear and pinion backlash at three equally spaced points on

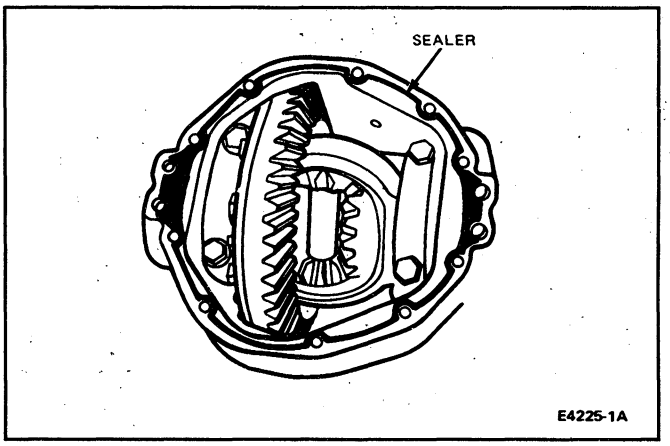


FIG. 59 Bead Surface

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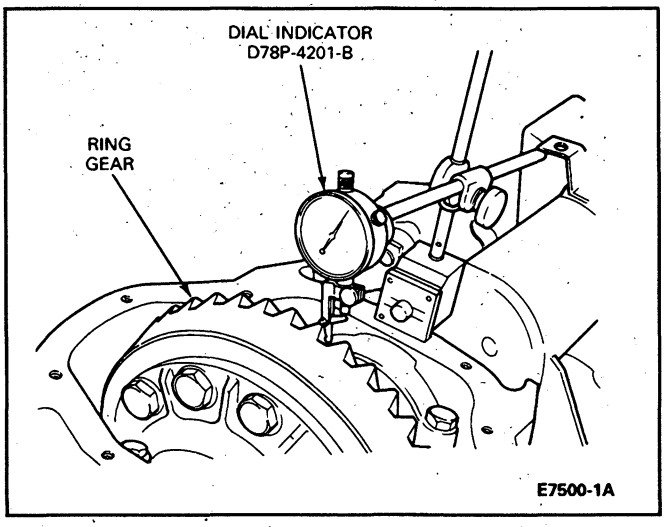


Fig. 60 Checking Backlash

the ring gear. Backlash tolerance is 0.13-0.23mm (0.005-0.009 inch) and cannot vary more than 0.08mm (0.003 inch) between the three points. If backlash is high, the ring gear must be moved closer to the pinion, by moving shims to the ring gear side from the opposite side. If backlash is low, the ring gear must be moved away from the pinion by moving shims from the ring gear side to the opposite side.

17. Obtain a gear tooth contact pattern check as outlined under 'Gear Tooth Contact Pattern Check' in this Section prior to complete reassembly (Fig. 60).

18. Apply a bead 3.175-6.35mm (1/8-1/4 inch) high and 3.175-6.35mm (1/4-1/2 inch) wide of Silicone Rubber sealant, D6AZ-19562-A (clear) or -BA (black) (ESB-M4G92-A and ESE-M4G195-A) or equivalent on the mating surfaces of the carrier mounting face support arm as shown in Fig. 59. **Allow one hour curing time after the axle carrier is assembled to the axle arm before installing lubricant and operating vehicle.**

19. Mount the differential assembly to the left hand axle arm, using 2 guide pins being careful not to smear gasket sealant. Install and tighten bolts to 41-54 N·m (30-40 ft. lb). Use new bolts with encapsulated adhesive or wire brush the old bolts and apply thread-locking compound, Threadlock and Sealer, E0AZ-19554-AA (ESE-M4G204-A) or equivalent. Install support arm tab bolts to side of carrier and tighten to 115-136 N·m (85-100 ft-lbs).

Gear Tooth Contact Pattern Check

1. When rolling a tooth pattern, use a special marking compound (tube) to obtain gear tooth mesh contact pattern.

2. To check the gear tooth contact, paint the gear teeth with the special marking compound.

NOTE: A mixture that is too wet will run and smear, too dry a mixture cannot be pressed out from between the teeth.

3. Rotate the ring gear (use a box wrench on the ring gear attaching bolts as a lever) several complete revolutions in both directions or until a clear tooth contact pattern is obtained.

4. Certain types of gear tooth contact patterns on the ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the ring gear and/or the pinion.

5. Fig. 61 shows acceptable tooth patterns for all axles. In general, desirable tooth patterns should have the following characteristics:

   A. The drive pattern should be fairly well centered on the tooth.

   B. The coast pattern should be fairly well centered on the tooth.

   C. Some clearance between the pattern and the top of the tooth is desirable.

   D. There should be no hard lines where the pressure is high.

6. An individual gear set need not conform exactly to the ideal pattern to be acceptable. Any combination of drive and coast patterns shown is acceptable.

7. Since each gear set rolls a characteristic pattern, the patterns shown are considered acceptable and should be used as a guide. The drive pattern is rolled on the convex side of the tooth, and the coast pattern is rolled on the concave side.

The movement of tooth contact patterns with changes in shimming can be summarized as follows:

   A. Thinner shim, with the back lash set to specification, moves the pinion farther from the ring gear.

   B. Thicker shim, with the back lash set to specification, moves the pinion closer to the ring gear.

NOTE: When making pinion position changes, shims should be changed in the range of .05mm (.002 inch) to .10mm (.004 inch) until correct pattern has been obtained.

8. If the pinion positioning shims are correct:

   - Decreasing backlash moves the ring gear closer to the pinion. Drive pattern (convex side of gear) moves slightly lower and toward the toe. Coast pattern (concave side of gear) moves lower and toward the toe.
   - Increasing backlash moves the ring gear away from the pinion. Drive pattern moves slightly higher and toward the heel. Coast pattern moves higher and towards the heel.

NOTE: If the patterns are not correct, make the changes as indicated. The differential case and drive pinion will have to be removed from the carrier housing to change a shim.

9. Check ring gear backlash by installing a dial indicator on the carrier housing. Check ring gear and pinion backlash at three equally spaces points on the ring gear. Backlash tolerance is 0.23mm (0.005-0.009 inch) and cannot vary more than 0.08mm (0.003 inch) between the three points. If backlash is high, the ring gear must be moved closer to the pinion, by moving shims to the ring gear side to the opposite side. If backlash is low, the ring gear must be moved away from the pinion by moving shims from the ring gear side to the opposite side.

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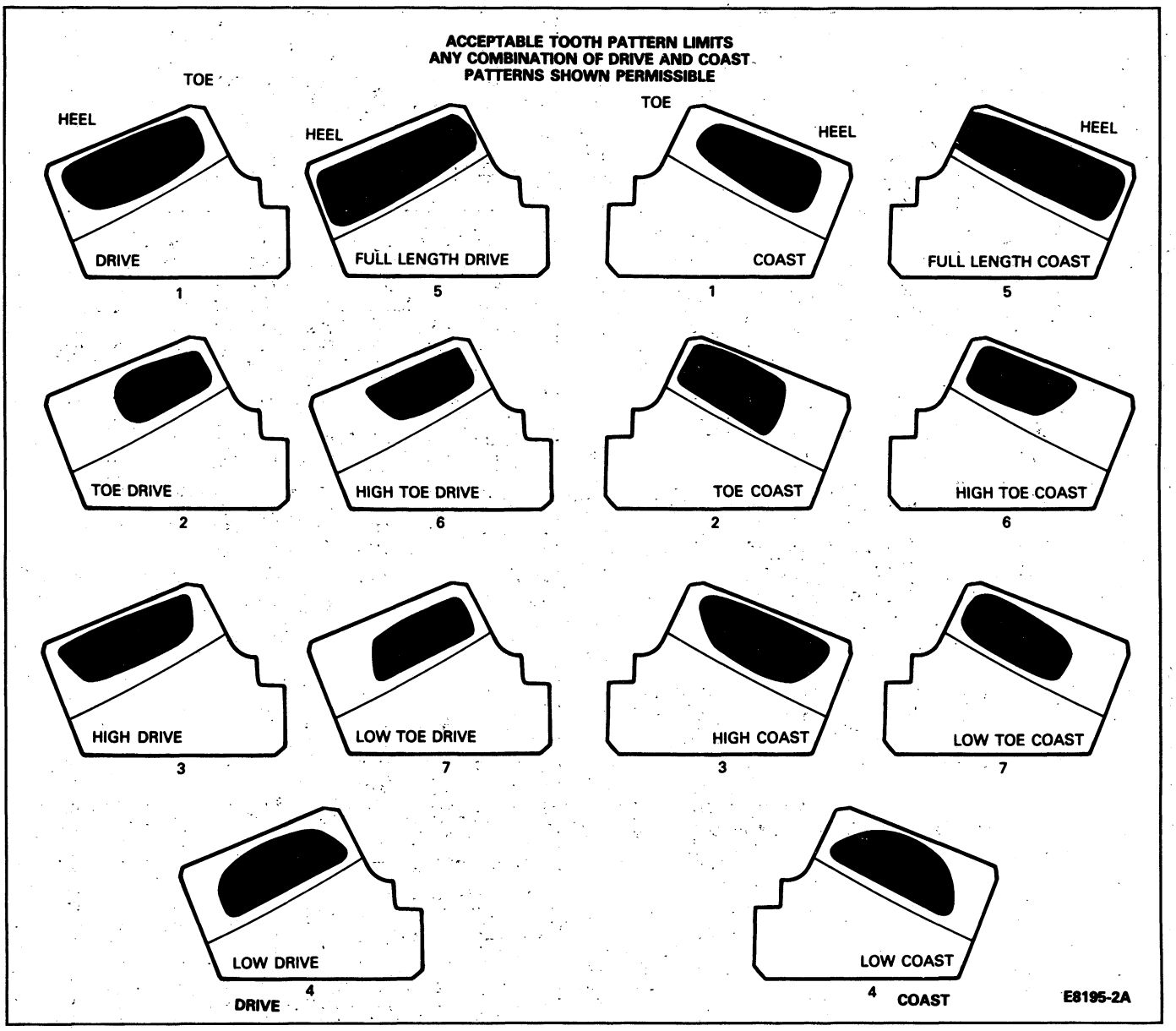
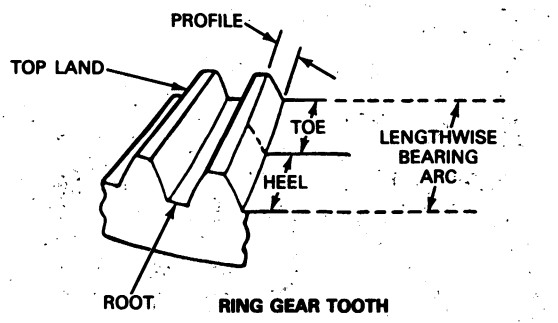


FIG. 61 Acceptable Gear Tooth Pattern Limits—Dana Axles

NOTE: When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .10mm (.004 inch), the shim pack should be changed by .15mm (.006 inch) as a starting point. The actual amount of backlash change obtained will vary depending upon the ratio and gear size.

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PATTERN INTERPRETATION (RING GEAR)

NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

THE TOE OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE END TOWARDS THE CENTER. THE HEEL OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE OUTER END. THE TOP LAND OF A GEAR TOOTH IS THE SURFACE OF THE TOP OF THE TOOTH.

E8196-1A

FIG. 62 Acceptable Gear Tooth Patterns—All Dana Driving Axles

DRIVE SIDE HEEL TOE	COAST SIDE TOE HEEL	
		**BACKLASH CORRECT.** THINNER PINION POSITION SHIM SHIM REQUIRED.
		**BACKLASH CORRECT.** THICKER PINION POSITION SHIM REQUIRED.

THICKER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION CLOSER TO THE RING GEAR.

DRIVE PATTERN MOVES DEEPER ON THE TOOTH (FLANK CONTACT) AND SLIGHTLY TOWARD THE TOE.

COAST PATTERN MOVES DEEPER ON THE TOOTH AND TOWARD THE HEEL.

THINNER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION FURTHER FROM THE RING GEAR.

DRIVE PATTERN MOVES TOWARD THE TOP OF THE TOOTH (FACE CONTACT) AND TOWARD THE HEEL.

COAST PATTERN MOVES TOWARD THE TOP OF THE TOOTH AND SLIGHTLY TOWARD THE TOE.

E8197-1A

FIG. 63 Pinion Positioning Shim—Adjustment

DRIVE SIDE HEEL TOE	COAST SIDE TOE HEEL	
		PINION POSITION SHIM CORRECT. DECREASE BACKLASH.
		PINION POSITION SHIM CORRECT. INCREASE BACKLASH.

HIGH BACKLASH IS CORRECTED BY MOVING THE RING GEAR CLOSER TO THE PINION. LOW BACKLASH IS CORRECTED BY MOVING THE RING GEAR AWAY FROM THE PINION. THESE CORRECTIONS ARE MADE BY SWITCHING SHIMS FROM ONE SIDE OF THE DIFFERENTIAL CASE TO THE OTHER.

E8198-1A

FIG. 64 Ring Gear Positioning Shim—Adjustment

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Slide Hammer	Oil Seal Removal
D79P-100-A	Slide Hammer	Needle Bearing Removal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-B	Forcing Screw	Needle Bearing Removal
D80L-100-T	Collet — 1-1/4 — 1-1/2 Inch	Needle Bearing Removal
T58L-101-B	Sealer Puller	Universal
D80L-630-5	Step Plate	Differential Side Bearing Removal
T77F-1102-A	Bearing Cup Puller	Oil Seal Removal
T75L-1165-B	Axle Bearing/Seal Plate	Drive Pinion Bearing Installation
T75T-1176-A	Forcing Screw	Bearing Cup Installation
D85T-1197-A	Spanner Locknut Wrench	Model 50 Inner Locknut Removal
T86T-1197-A	Spanner Locknut Wrench	Model 44 Adjusting Nut Removal
T83T-1244-A	Needle Bearing Replacer	Needle Bearing Installation
T80T-3010-A1	Replacer	Upper Ball Joint Installation
T80T-3010-A3	Receiving Cup	Ball Joint Installation
T80T-3010-A4	Plug	Ball Joint Removal
D81T-3010-A	Installing Cup	Ball Joint Installation — F-150-F-250
D81T-3010-A	Receiving Cup	Ball Joint Removal — F-150-F-250
T80T-3010-A2	Receiver Cup	Ball Joint Installer — F-350
T64P-3590-F	Pitman Arm Puller	Pitman Arm Removal
D81L-4000-A	Driver Handle	Cup Removal
T80T-4000-B	Spreader Adapter	Differential Case Removal and Installation
T80T-4000-C	Oil Seal Replacer	Oil Seal Installation
TOOL-4000-E	Spreader Tool	Differential Case Removal and Installation
T80T-4000-D	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 44
T80T-4000-E	Bearing Cup Replacer	Outer Bearing Cup Installation — Model 44 and 50
T80T-4000-F	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 50
T83T-4851-A	Companion Flange Replacer	Yoke Installation
T80T-4000-H	Differential Seal Replacer	Differential Seal Installation
T80T-4000-J	Differential Bearing Replacer	Differential Side Bearing Installation
T80T-4000-L	Sleeve	Axle Bearing Removal
T80T-4000-M	Axle Bearing Remover	Axle Bearing Removal
T80T-4000-N	Axle Bearing Replacer	Axle Bearing Installation
T80T-4000-S	Spindle Bearing Replacer	Needle Bearing Installation — Bronco — F-150-F-250
T80T-4000-R	Spindle Bearing Installer	Spindle Bearing — F-350
T80T-4000-T	Seal Replacer	Seal Installation — Bronco — F-150-F-250
T80T-4000-U	Seal Replacer	Seal Installation — F-350
T80T-4000-W	Driver Handle	Bearing and Seal Installation
T75P-4020-A2	Aligning Adapter	Axle Adjustments
T76P-4020-A11	Handle	Axle Adjustments
T80T-4020-A	Pinion Depth Gauge	Truck
T80T-4020-F40	Gauge Disc	Axle Adjustments — Model 50
T80T-4020-F41	Gauge Tube	Axle Adjustments — Model 50
T80T-4020-F42	Gauge Block	Axle Adjustments
T80T-4020-F43	Screw	Axle Adjustments
D80T-4020-F44	Gauge Disc	Axle Adjustments — Model 44
D80T-4020-F47	Gauge Tube	Axle Adjustments — Model 44
D80T-4020-F49	Gauge Tube	Axle Adjustments
D81T-4020-FX	Final Check Pinion Depth Gauge	Truck
D81T-4020-F52	Final Check Gauge Block	Axle Adjustments — Model 44
D81T-4020-F53	Final Check Gauge Block	Axle Adjustments — Model 50
TOOL-4201-C	Dial Indicator	Axle Adjustments

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SPECIAL SERVICE TOOLS (Cont'd.)

Number	Description	Application
D78L-4201-B	Dial Indicator	Magnetic Base
D81I-4220-A	Universal Bearing Remover	Bearing Removal
D81T-4222-B	Master Bearings	Axle Adjustments — Model 44
D81T-4222-C	Master Bearings	Axle Adjustments — Model 50
T53T-4621-B, C	Pinion Bearing Cone Replacer	Drive Pinion Bearing Installation — Model 44
T71P-4621-B	Pinion Bearing Cone Remover	Axle Bearing Installation
D81T-4628-C	Pinion Bearing Cup Remover	Inner Bearing Cup Removal — Model 44
D81T-4628-D	Pinion Bearing Cup Remover	Inner Bearing Cup Removal — Model 50 Outer Bearing Cup Removal — 44 and 50
T74P-4635-C	C-Frame Assembly	—
T65L-4851-B	Yoke Remover	—
T78P-4851-A	Holding Tool	Yoke Removal and Installation
T83T-4851-A	Companion Flange Replacer	—
T78P-5638-A1	Forcing Screw	Bushing Removal and Installation
T80T-5638-A1	Bushing Remover	Bushing Removal
T78P-5638-A2	Receiver Cup	Bushing Installation
T80T-5638-A2	Bushing Replacer	Bushing Installation
T78P-5638-A3	Receiver Cup	Bushing Removal
T78P-5638-A4	Receiver Cup	Bushing Removal
T75L-500-B	Bench Mounted Holding Fixture	Universal
T80T-4000-K	Differential Bearing Remover	—
T80T-4000-P	Inner Hub Bearing Cup Replacer	F150, Bronco
T80T-4000-Q	Inner Hub Bearing Cup Replacer	F-250
T63P-9171-A	Keystone Clamp Pliers	—

CE5103-2D

TORQUE SPECIFICATIONS — DANA FRONT DRIVE AXLE

Description	Torque	
	N·m	(ft-lbs)
Bottom Ball Joint Nut	122-149	90-110
Top Ball Joint Nut	135 (Minimum)	100 (Minimum)
End Yoke Nut	271-298	200-220
Bearing Cap Bolts	108-122	80-90
Differential Retaining Bolts	41-54	30-40
Ring Gear Bolts	61-81	50-60
Support Arm Tabs to Carrier Bolts	115-136	85-100

DANA AXLE ADJUSMENTS

Description	Specification
Drive Pinion Preload	2.25-2.43 N·m (20-40 in-lbs)
Ring Gear Backlash	0.13-0.23mm (0.005-0.009 inch) No more than 0.08mm (0.003 inch) variation in any three places

LUBRICANT CAPACITY ①

Axle Model	Approximate Capacity		
	U.S. Pints	Imperial Pints	Liters
Dana 44 — IFS	3.9	3.2	1.7
Dana 50 — IFS	4.1	3.4	1.8

①Use Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent.

CE4125-1D

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SECTION 15-41 Traction-Lok Differential—Ford 8.8 Inch Ring Gear

SUBJECT	PAGE
ADJUSTMENTS	
Bench Torque Test	15-41-8
Clutch Pack Preload Adjustment	15-41-3
DESCRIPTION AND OPERATION	
Description	15-41-1
Noise Acceptability	15-41-2
Operation	15-41-1
DIAGNOSIS AND TESTING	
Limited-Slip Differential Operation Check	15-41-2
DISASSEMBLY AND ASSEMBLY	
Differential Case	15-41-8
REMOVAL AND INSTALLATION	15-41-8
SPECIFICATIONS	15-41-8
VEHICLE APPLICATION	15-41-1

VEHICLE APPLICATION

All E-150, F-150 and Bronco Vehicles Equipped with 8.8 Inch Ring Gear Axle.

DESCRIPTION AND OPERATION

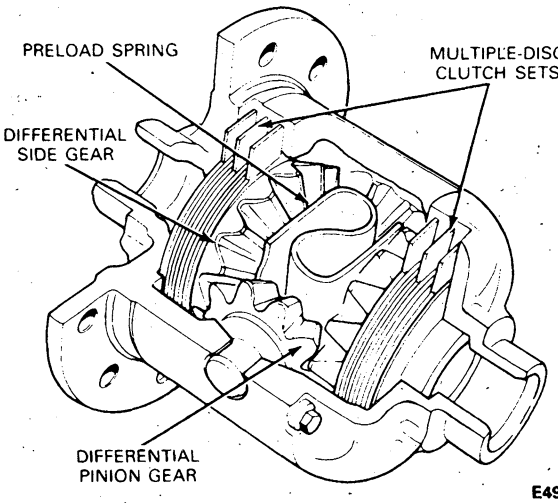
Description

The Limited Slip axle assembly, except for the differential case and its internal components, is identical to the conventional axle.

The Limited Slip differential employs two sets of multiple-disc clutches to control differential action. The side gear mounting distance is controlled by seven plates on each side: four steel, three friction, and one steel shim. This steel shim is of the selective type to control side gear position.

The plates are stacked on the side gear hub and are housed in the differential case. Also located in the differential case, between the side gears, is a one-piece pre-load spring, which applies an initial force to the clutch packs. Additional clutch capacity is delivered from the side gears thrust loads. Splined plates are splined to the side gear hubs which, in turn, are splined to the left and right axle shaft. The eared friction plates are dogged to the case, thus, the clutch packs are always engaged.

SECTIONAL VIEW OF DIFFERENTIAL ASSEMBLY



E4975-1C

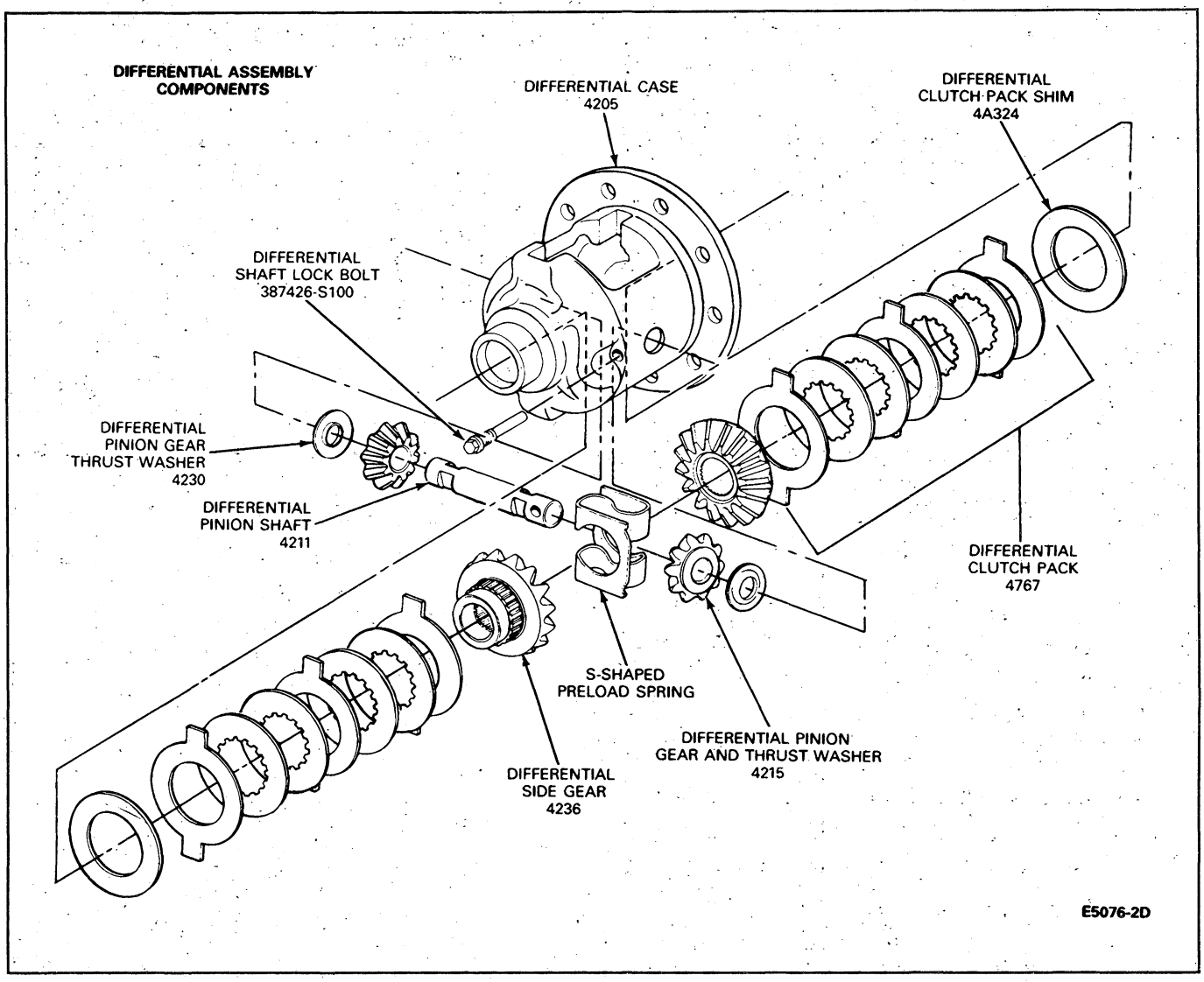
Operation

The pressure between clutch plates opposes differential action at all times. When the vehicle turns a corner the clutch slips, allowing normal differential action to take place. Under adverse weather conditions, where one or both wheels may be on a low-traction surface such as snow, ice or mud, the friction between the clutch plates will transfer a portion of the usable torque to the wheel with the most traction. Thus, the wheel that is on ice or snow will have a tendency to operate with the opposite wheel in a combined driving effort.

CAUTION: Extended use of other than conventional spare tires on a Traction-Lok rear axle could result in reduction in effectiveness (bias torque). This loss of effectiveness does not affect normal driving and should not be noticeable to the driver. However, extended usage will reduce the ability of the axle to provide added traction on slippery surfaces.

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DESCRIPTION AND OPERATION (Continued)



Noise Acceptability

A gear-driven unit (especially on a drive axle) will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions. For example, as on a newly paved blacktop road. The slight noise is in no way detrimental to operation of the rear axle and must be considered normal.

NOTE: Vehicles equipped with a Limited-Slip differential may exhibit a slight stick-slip noise on tight turns after extended highway driving. This is considered acceptable and has no detrimental effect.

DIAGNOSIS AND TESTING

Limited-Slip Differential Operation Check

A Limited-Slip differential can be checked for proper operation without removing the differential from the axle housing.

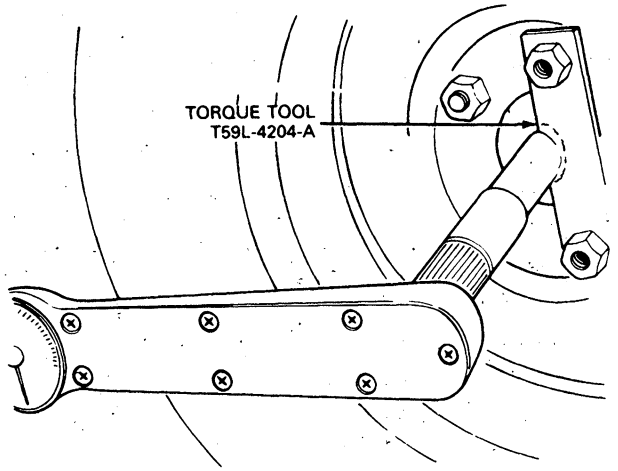
1. Jack up one rear wheel and remove the wheel cover. Install Torque Tool, T59L-4204-A or equivalent on the axle shaft flange studs as shown.

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DIAGNOSIS AND TESTING (Continued)

2. Using a torque wrench of at least 271 N·m (200 ft-lbs) capacity, rotate the axle shaft. Be sure that the transmission is in Neutral, one rear wheel is on the floor, and the other rear wheel is raised off the floor. The break-away torque required to start rotation should be at least 27 N·m (20 ft-lbs). The initial break-away torque may be higher than the continuous turning torque, but this is normal. The axle shaft should turn with even pressure throughout the check without slipping or binding. If the torque reading is less than specified, check the differential for proper assembly.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF, WHILE THE VEHICLE IS BEING SERVICED, ONLY ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE IS DRIVEN BY THE ENGINE, THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK.



E5121-1C

ADJUSTMENTS

In-vehicle adjustments are possible on this unit without removing the differential case from the axle housing. If the operation check was not to specification, the following procedure can be used to correct the condition:

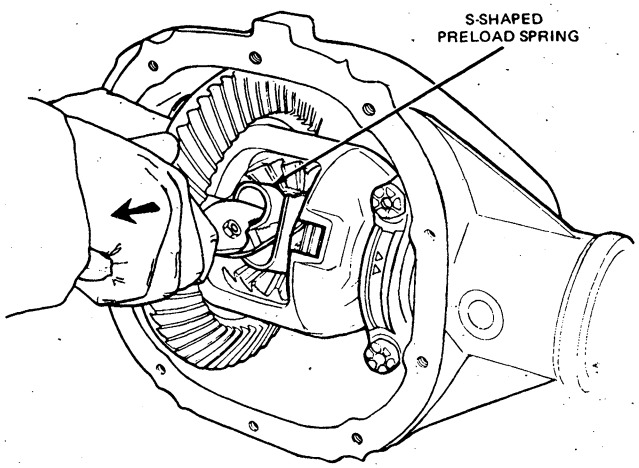
NOTE: Refer to Section 15-08 (Conventional 8.8 inch Ring Gear Axle), for Exciter Ring Service on Antilock brake system equipped vehicles.

Clutch Pack Preload Adjustment

NOTE: Before clutch pack preload can be adjusted, the axle shafts must be removed following the procedure in Section 15-08, Integral Carrier Axle—Ford Truck 8.8 Inch Ring Gear. The shafts must be removed completely from the housing so that the oil seals will not be damaged. After adjustment, install the shafts following the procedure in Section 15-08.

1. With a suitable drift, drive the S-shaped preload spring half-way out of the differential case. Rotate the differential case 180 degrees. Hold the S-shaped preload spring with a pair of pliers and tap the spring until it is removed from the differential.

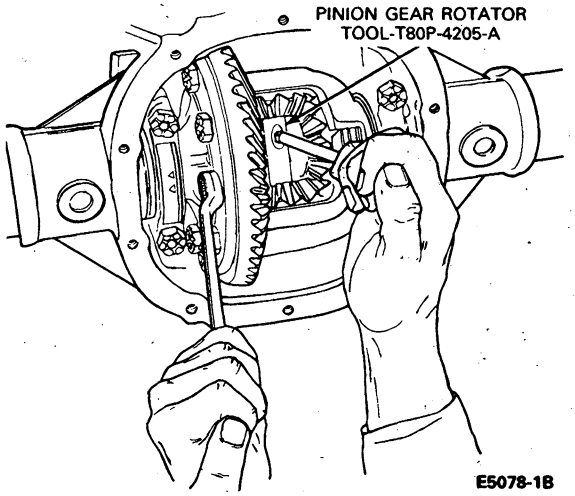
WARNING: CARE MUST BE USED WHEN REMOVING THE PRELOAD SPRING DUE TO THE SPRING TENSION.



E5077-1A

2. Using Gear Rotator T80P-4205-A or equivalent, rotate the pinion gears until the gears can be removed from the differential.

NOTE: A twelve inch extension is required to remove the pinion gears.

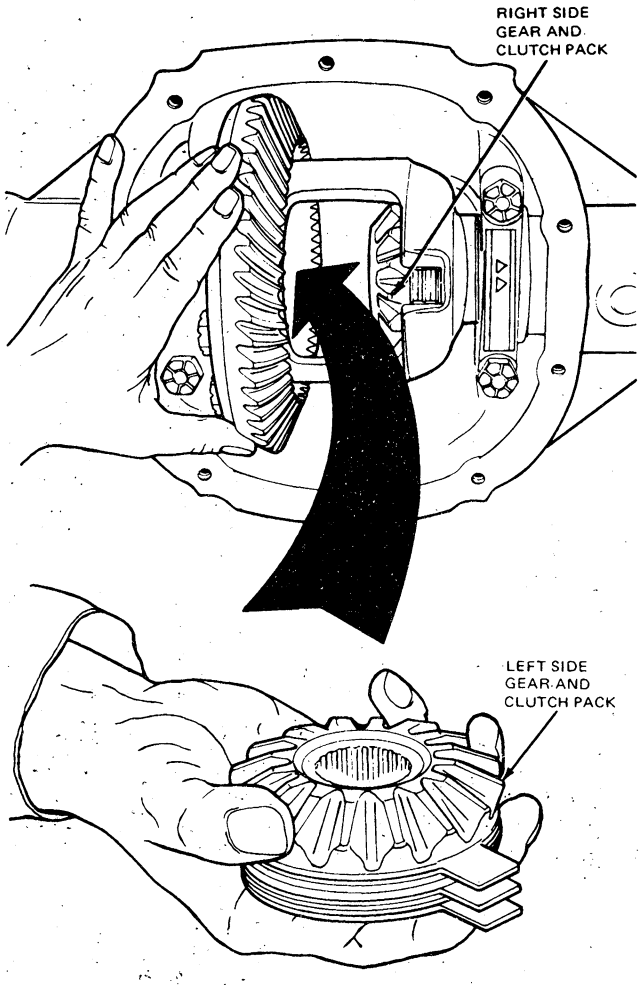


E5078-1B

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ADJUSTMENTS (Continued)

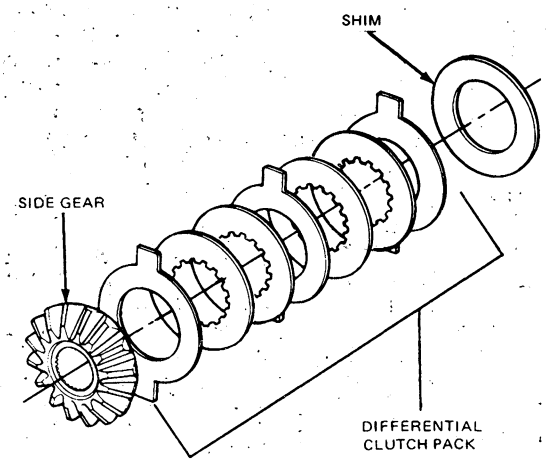
3. Remove the right and left side gear and clutch pack with the shim and tag them R.H. and L.H. Set them aside until Step 4. Clean and inspect the remaining parts of the differential case assembly for wear or damage. Replace parts as required.



E5079-1A

4. Clean and inspect the clutch packs for wear and replace parts as necessary.

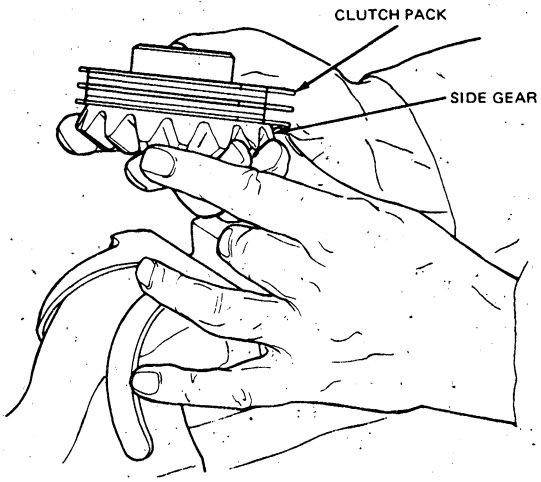
NOTE: Do not use acids or solvents when cleaning clutch components. Wipe components with a clean lint-free cloth only.



E5085-1A

5. Assemble the clutch packs (without shims) on the respective side gears. Pre-lubricate all friction plates with Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent.

NOTE: Do not mix clutch plates or shims from one side with the other.

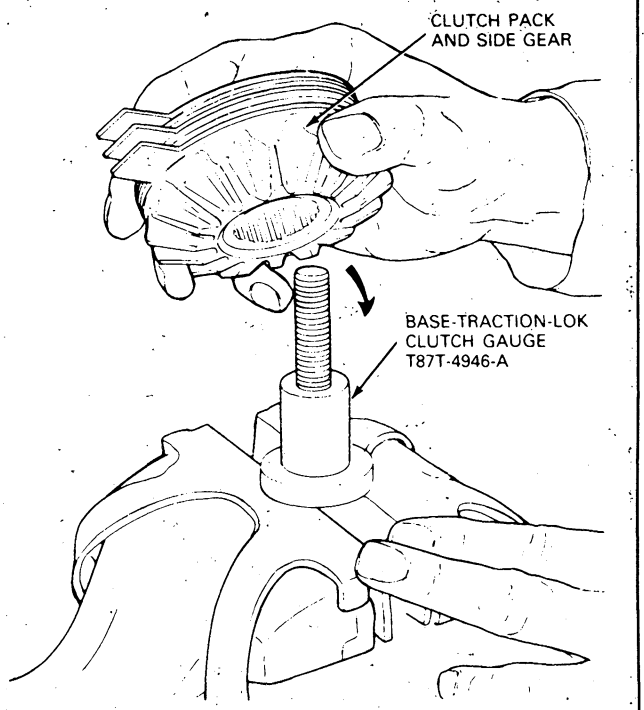


E5080-1A

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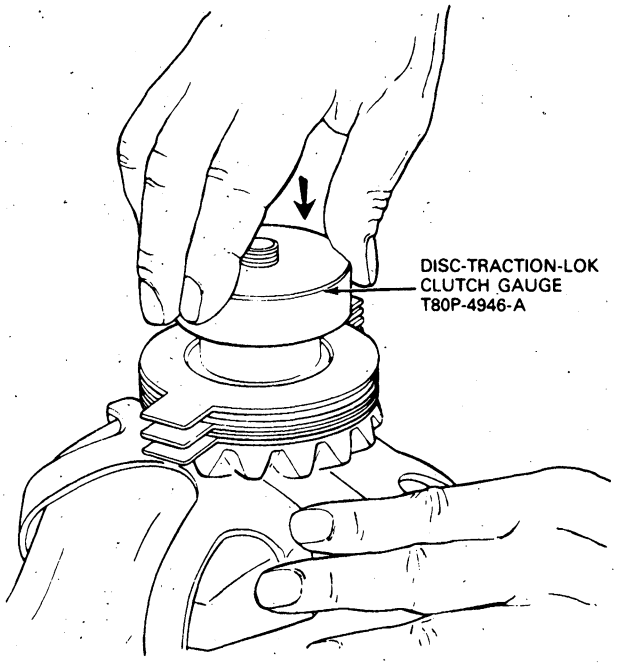
ADJUSTMENTS (Continued)

6. Place the base portion of Traction-Lok Clutch Gauge, T87T-4946-A in a vise. Install the clutch pack and side gear (without the differential clutch pack shim) over the base.



E5723-1B

7. Install the disc of Traction-Lok Clutch Gauge, T80P-4946-A over the base and on top of the clutch pack.

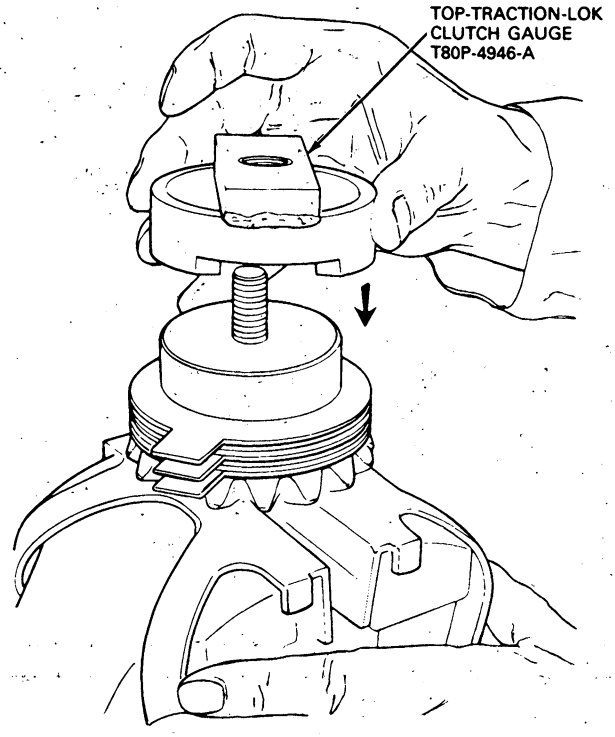


E5724-1A

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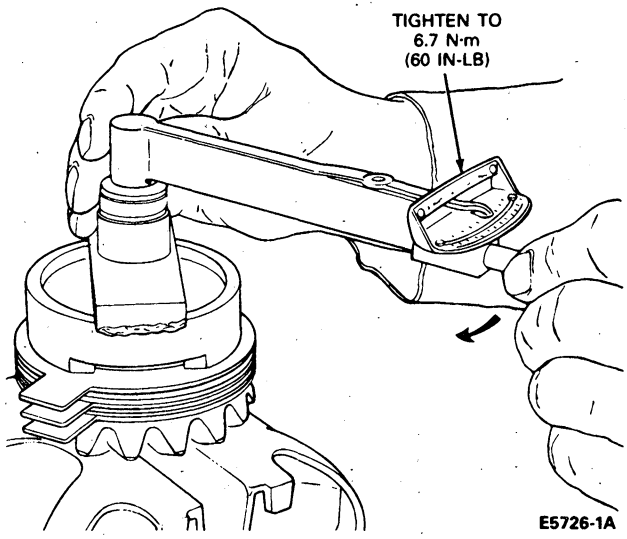
ADJUSTMENTS (Continued)

8. Install the top portion of Traction-Lok Clutch Gauge, T80P-4946-A over the disc and base stud.



E5725-1A

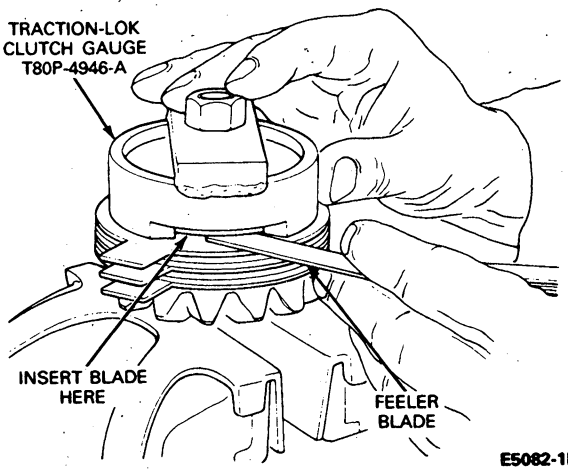
9. Install the nut of Traction-Lok Clutch Gauge, T80P-4946-A over the top and base stud. Tighten the nut to 6.7 N·m (60 in-lbs).



E5726-1A

10. Using a feeler gauge, select the thickest blade that will enter between the tool and the clutch pack. This reading will be the thickness of the new shim.

NOTE: Be sure to lubricate friction plates with the proper Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent prior to reassembly.

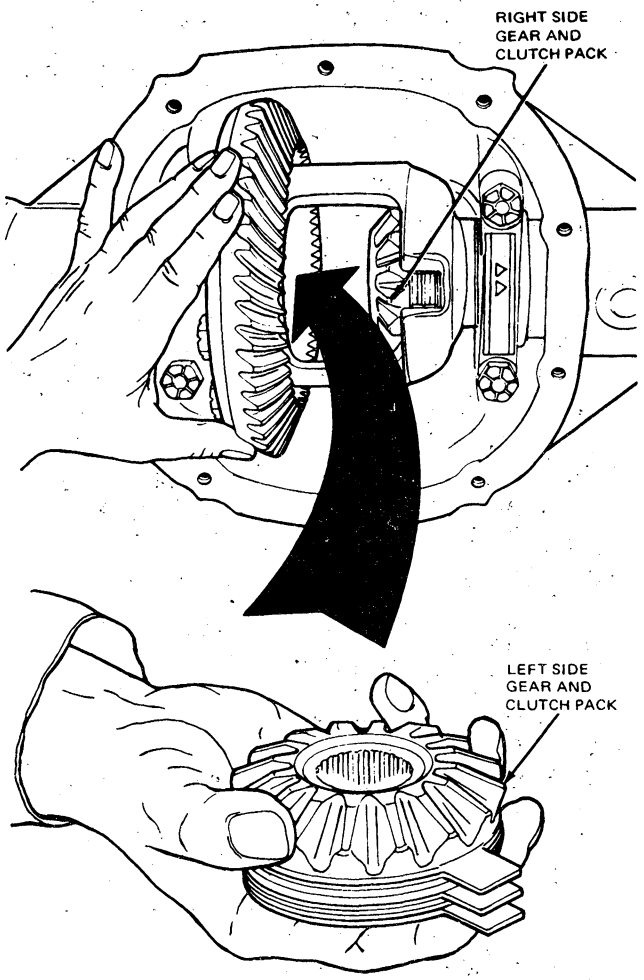


E5082-1B

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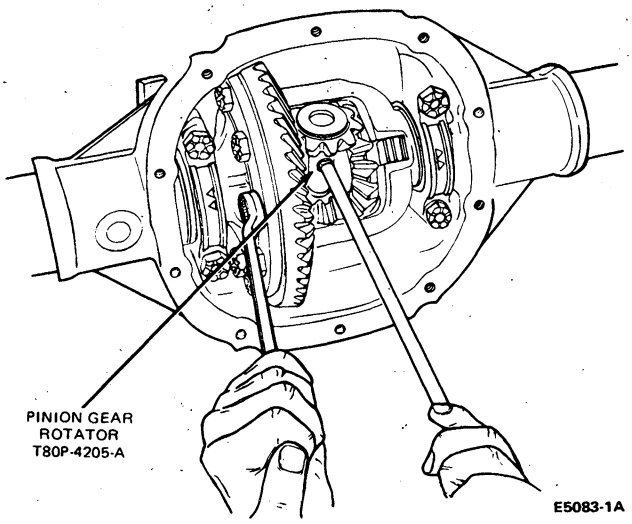
ADJUSTMENTS (Continued)

11. Install the right side-gear, clutch pack and new shim into the cavity in the differential case. Repeat this step for the left side.

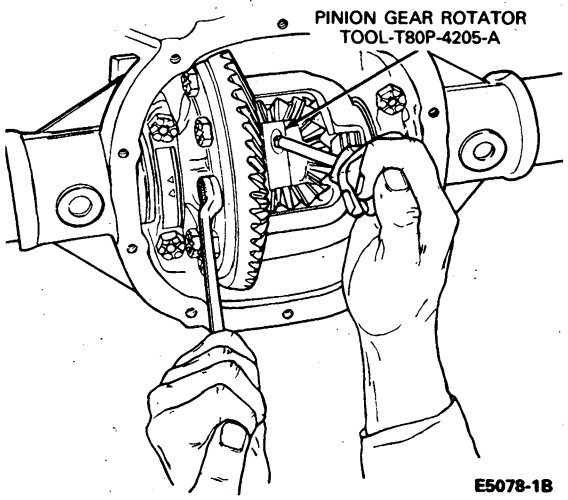


12. Place the pinion gears and thrust washers 180 degrees apart on the side gears. Install Tool T80P-4205-A or equivalent as shown.

NOTE: A twelve inch extension is required to install the pinion gears.



13. Rotate the tool until the pinion gears are aligned with the pinion shaft hole as shown. Remove the tool from the differential case.

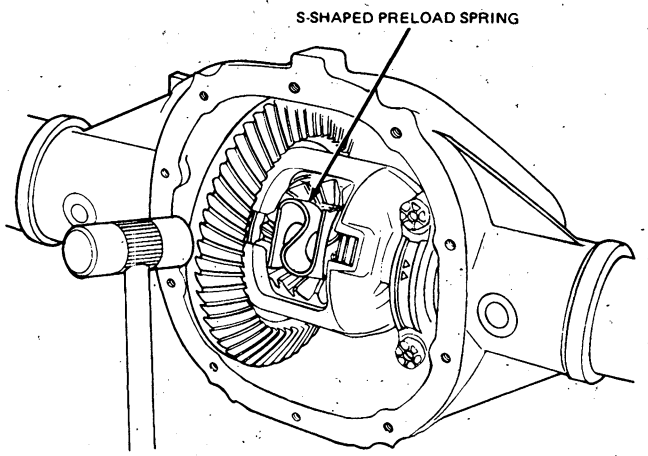


14. Hold the S-shaped preload spring up to the differential case window and with a soft-faced hammer, hammer the spring into position.

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ADJUSTMENTS (Continued)

NOTE: Inspect the pre-load spring for damage.



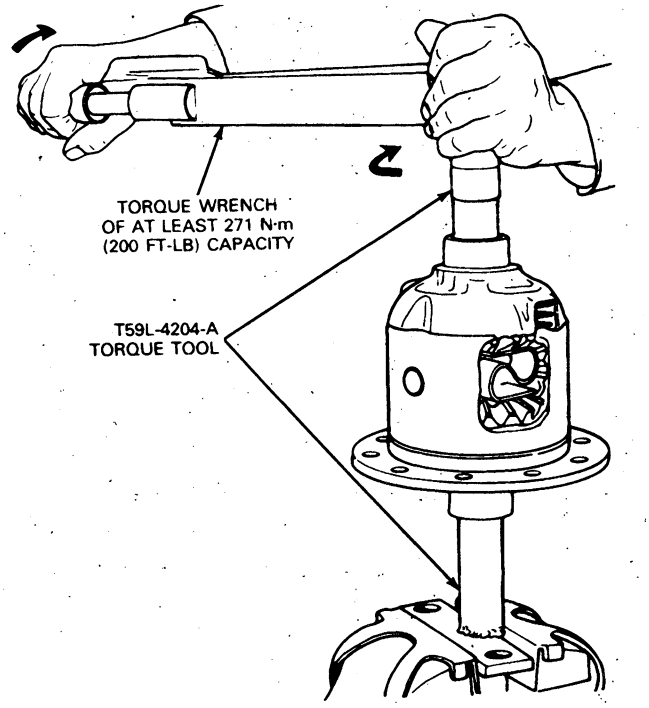
E5084-1A

Bench Torque Test

A bench torque test must be made **if** the differential assembly has been removed from the axle and adjustments have been made.

With the locker tools in T59L-4204-A or equivalent check the torque required to rotate one side gear while the other is held stationary.

The initial break-away torque, if original clutch plates are used, should be at least 27 N·m (20 ft-lbs). The rotating torque required to keep the side gear turning with new clutch plates may fluctuate.



E5712-1C

REMOVAL AND INSTALLATION

Removal and installation procedures for the Limited-Slip differential axle shaft, axle shaft seal and bearing, axle housing and pinion oil seal are the same as those for the Ford truck 8.8 inch ring gear integral carrier axle with a conventional differential. Refer to Section 15-08, Integral Carrier Axle—Ford—8.8 Inch Ring Gear, for these procedures.

DISASSEMBLY AND ASSEMBLY

Differential Case

Refer to Section 15-08, Integral Carrier Axle—Ford—8.8 Inch Ring Gear, Axle Housing Disassembly and Assembly for the procedures for removing and installing the Limited-Slip differential.

The differential is removed and installed in the same manner as a conventional differential.

To disassemble and assemble the case, remove and install the ring gear and differential cone and roller assemblies following the procedures used for the conventional differential.

NOTE: It is not necessary to remove the differential cone and roller assemblies from the case journals unless they are damaged. If the bearings remain on the case during repair, keep them clean and free from foreign material.

To remove and install the preload spring, pinion shaft and gears, and clutch packs, follow the procedure under Adjustments in this section.

SPECIFICATIONS

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — LIMITED-SLIP

Description	Torque (In-Lb) N·m	Torque (Ft-Lb) N·m
Approximate torque required to tighten pinion flange nut to obtain correct pinion bearing preload	—	(160)① 217
Pinion Bearing Preloader Used Bearings New Bearings	(8-14) .9-1.6 (17-27) 2.0-3.0	—
Minimum rotating torques required during bench check after assembly or in vehicle with one wheel on the ground for original clutch pack.		27 (20)

①If pinion bearing preload exceeds specification before this torque is obtained, install a new spacer.
②With Oil Seal.

CE5105-1D

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SPECIFICATIONS (Continued)

DRIVING AXLE IDENTIFICATION (INTEGRAL CARRIER) — LIMITED-SLIP

Identification Tag	Ratio	Ring Gear Diameter (Inches)	Type
807E	3L55:1	8.8	T2
815E	4L10:1	8.8	T2
817P	3L55:1	8.8	T2
731P	3L55:1	8.8	T2
733D	3L55:1	8.8	T2

CE5107-1F

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER) — LIMITED-SLIP

Vehicle	Engine	Axle	U.S. Measure Capacity (Pints)①	Imperial Capacity (Pints)①	Liters①
E-150, F-150 Bronco	All	8.8 Inch Ring Gear	5.5	4.6	2.6

①Use Hypoid Gear Lubricant E0AZ-19580-A (ESP-M2C154-A) lubricant or equivalent. Add 4 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A, (EST-M2C118-A) or equivalent.

CE5108-1D

BACKLASH BETWEEN RING GEAR AND PINION

Backlash — 0.20-0.46 mm (0.008-0.18 in.)
Runout — 0.203 mm (0.008 in.)

CE7109-1A

TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — LIMITED-SLIP

Description	Torque (Ft-Lb) N·m
Differential Bearing Cap Bolt — Inch	(70-85) 95-115
Differential Pinion Shaft Lock Bolt	(15-30) 20-40
Ring Gear Attaching Bolts - Inch①	(70-85) 95-115
Rear Cover Screw	(25-35) 34-47
Oil Filler Plug	(15-30) 20-40
Brake Backing Plate Nuts F-150/Bronco	(20-40) 28-54
Driveshaft to Axle Half-Round Companion Flange — F-150 and Bronco	(8-15) 11-20
Driveshaft to Axle Circular Companion Flange — E-150	(70-95) 95-129

①Using Loctite (or equivalent)

CE5106-1C

SPECIAL SERVICE TOOLS

Tool Number	Description
T59L-4204-A	Torque Tool
T80P-4205-A	Differential Gear Rotator
T80P-4946-A	Differential Clutch Gauge
T87T-4946-A	Differential Clutch Gauge — Base

CE5109-1C

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SECTION 15-42 Limited-Slip Differential—Dana

SUBJECT	PAGE
DESCRIPTION AND OPERATION	15-42-1
DIAGNOSIS AND TESTING	15-42-3
DISASSEMBLY AND ASSEMBLY	
Dana Limited-Slip Axles	15-42-4
Differential Case	15-42-4
Model 44IFS, 44IFS-HD, 60-1U 2-Pinion (Dana Trac-Lok)	15-42-4
DISASSEMBLY AND ASSEMBLY (Cont'd)	
Differential Case (Cont'd)	
Model 70 (4-Pinion) Power-Lok	15-42-7
REMOVAL AND INSTALLATION	15-42-4
SPECIFICATIONS	15-42-9
VEHICLE APPLICATION	15-42-1

VEHICLE APPLICATION

E-250 Through E-350 Rear Axle, F-150 Through F-350 (4x4) and Bronco Front Axle Vehicles.

DESCRIPTION AND OPERATION

The limited-slip Dana Trac-Lok Model 44 IFS, Model 44 IFSHD and Model 60-1U two pinion axle (Fig. 1) and the four pinion Dana Power-Lok Model 70 (Figs. 2 and 4) have a power flow identical to the conventional rear axle, plus a more direct power flow which automatically takes effect as driving conditions demand. This more direct power flow is from the differential case to each axle shaft through clutches (Fig. 3).

A conventional differential transmits all of the ring gear torque through the differential gears to the axle shafts. Torque is at all times equal on the axle shafts, and if one wheel slips, the other wheel can only put out as much torque as the slipping wheel. The limited-slip differential is similar, except that part of the torque from the ring gear is transmitted through clutch packs between the side gears and differential case. The multiple-disc clutches, with radial grooves on the plates and concentric grooves on the discs, are engaged by a preload from dished springs and separating forces from the side gears. This occurs as torque is applied through the ring gear.

CAUTION: Model 60 clutch packs are phasing in discs with a special surface coating in place of the concentric grooves. Model 70 clutch packs are phasing in plates with the special surface coating in place of the radial grooves. Discs and plates of this design should be soaked in Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent, prior to assembly for twenty minutes.

Each clutch plate and disc pack consists of steel plates, set between the case and the side gear ring. The clutch plates, having external lugs, are locked to the differential case by the external lugs. The clutch plate that is installed next to the case is a Belleville spring plate. This plate is installed with the concave (dished) side against the case. The remaining clutch discs have internal spline teeth which lock to the splined hub on the side gear ring. Each clutch pack is premeasured for proper stack height. Do not separate packs and inter

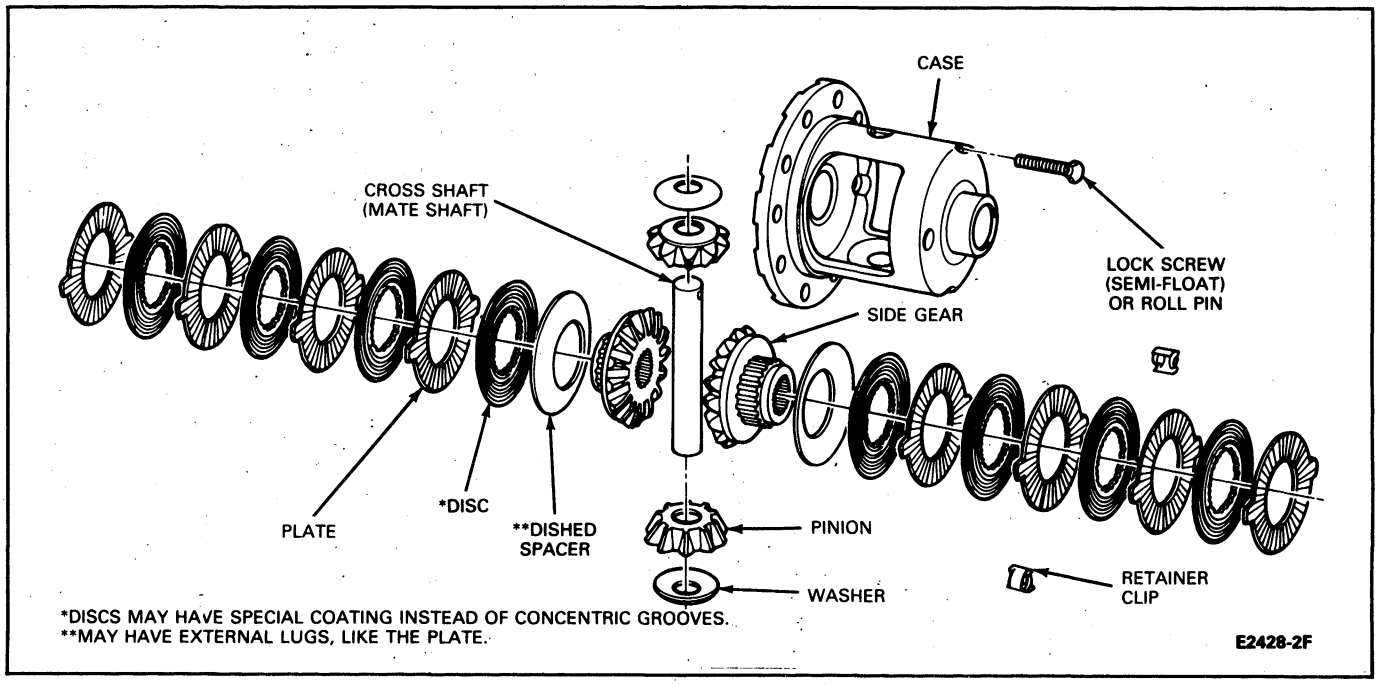


FIG. 1 Two Pinion Limited-Slip Differential—Model 44-IFS and Model 60-1U Trac-Lok

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mix the plates and discs from the packs. The side gear ring is, in turn, splined to the axle shaft and acts as a pressure plate against the clutch pack. Since the side gear ring fits against the pinions on the cross shaft (mate shaft), any outward force exerted by the mate shaft and its pinions will press the ring against the clutch pack and thus connect the differential case directly to the axle shaft.

Unlike the cross shafts of the conventional unit, the 4 pinion limited-slip differential mate shafts are not rigidly attached to the differential case, nor are they attached to each other. At both ends of the mate shafts there are two flat surfaces so arranged that they form a V which mates with corresponding V-shaped surfaces (ramps) cut in the shaft openings of the differential case. The mate shafts are assembled in the case with enough clearance so that when the case tries to rotate, they resist rotation. They are then forced to bear against one side of their V ramps. Since the two V ramps of one mate shaft point in a direction opposite to those of the other pin, the two shafts with their pinions will be forced apart as they resist rotation. This mate shaft movement compresses the clutch pack through the pinion gears and side gear rings.

When the differential case rotates in the opposite direction, the mate shafts will be forced to bear against the opposite side of their V ramps and will again be forced apart to apply against the clutch packs. Therefore, since the ramps are V-shaped, the clutches will apply during either forward or reverse operation. Likewise, the clutches will apply whether the power flow is from the differential case to the axle shafts, or from the axle shaft to the differential case.

The amount of compression on the clutch plates will be proportionate to the load applied to the differential case and the resistance to turning offered by each mate shaft. For example, if the vehicle is driven straight ahead and the traction or load on both wheels is equal, both mate shafts will give equal resistance to the rotating differential case and will thus bear against their respective ramps with equal force. This equal movement of the mate shafts will cause them to exert equal pressure against both right and left clutch packs. Both axle shafts will, therefore, be locked directly to the case with equal force. Fig. 4 shows a cutaway view of a Model 70 axle Power-Lok differential assembly.

The limited-slip differential prevents momentary spinning of one of the wheels when it leaves the road because of a bump, or encounters poor traction

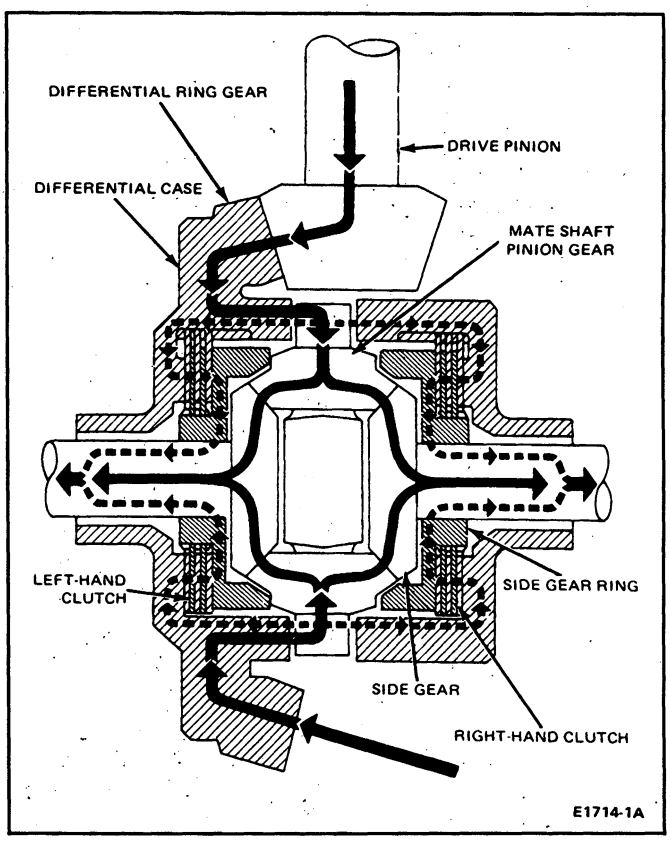


FIG. 3 Limited-Slip Differential Power Flow with Both Wheels Driving

because of a slippery road. Under these conditions, even though the traction load is relieved on the one wheel, the acceleration load is simultaneously applied to the differential case as the engine tries to spin the wheel.

When the rear axle is in a turn, the appropriate clutch releases automatically to allow normal differential operation as required. In the straight-ahead position, the differential case is driving both wheels and thus applies an equal load against both mate shafts. Since both mate shafts offer resistance to this load, both clutches are applied. On a turn, however, the outside wheel turns faster than the inside wheel. The outside wheel, instead of being driven by the case, now tends to drive the case. With the power thus relieved, the differential case releases its load against the outside wheel mate shaft

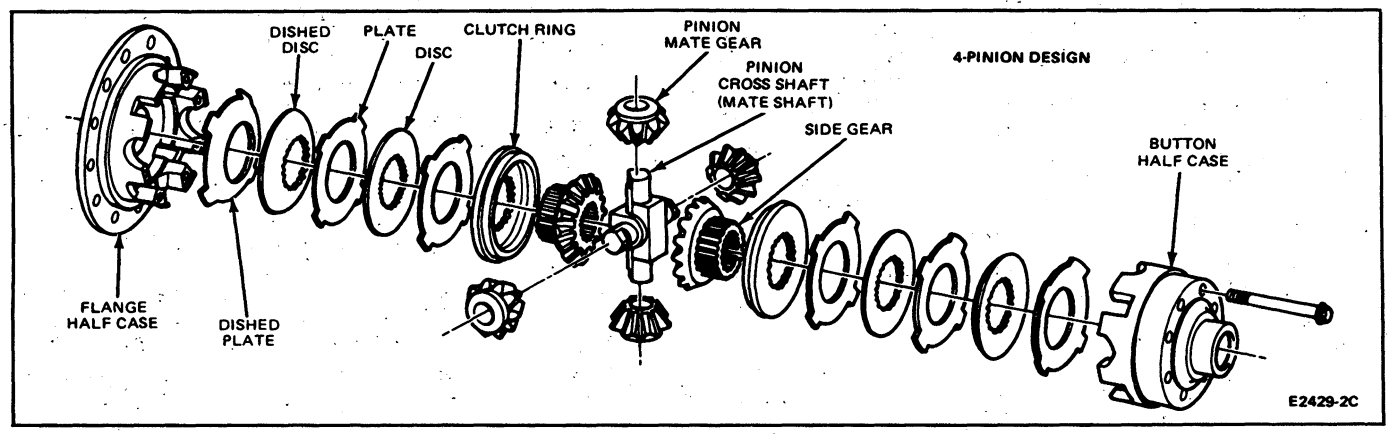


FIG. 2 Four Pinion Limited-Slip Differential—Model 702U and 70HD Powerlok. Design with Radial Grooves on Plates, Outer Dished Plate, and One Dished Disc per Clutch Pack (See Fig. 16 for Newer Design)

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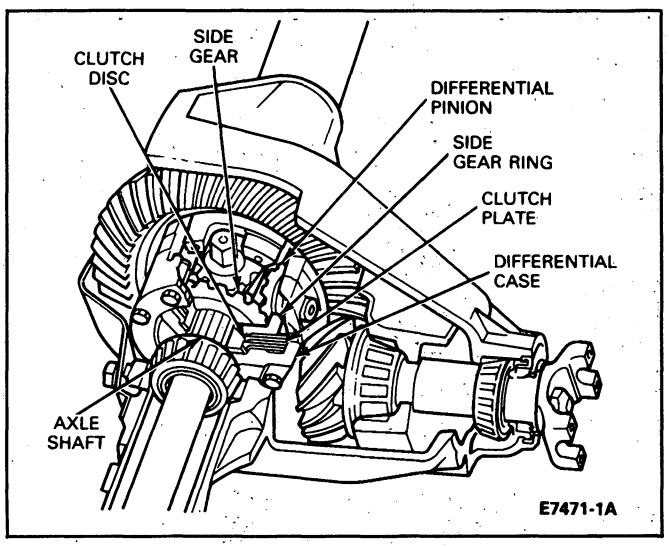


FIG. 4 Limited-Slip Differential—Model 702U and 70HD Power-Lok

which, in turn, releases its pressure against the outside wheel clutch pack. With the clutch released, normal differential action will take effect.

For a complete understanding of limited-slip operation, it is important to recognize two things:

1. If with equal traction, both wheels slip, the axle has done all it can do.
2. In extreme cases of differences of traction, the wheel with the least traction may spin after the axle has transferred as much torque as possible to the non-slipping wheel.

DIAGNOSIS AND TESTING

If noises or roughness such as chatter are present when turning corners, the probable cause is incorrect or contaminated lubricant.

Before any differential is removed and dissassembled for chatter complaints, the correctness of lubricant should be determined.

Verify the axle has the specified quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent and 0.236L (8 ounces) of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles and 0.059L (two ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for front drive axles. Warm the axle up and recheck for chatter by making a minimum of ten figure-eight type turns.

If this is unsuccessful, a complete lubricant drain, flush and refill will usually correct chatter. The following procedure is recommended to ensure that the system is flushed of old lubricant.

1. Warm the lubricant by vehicle road operation or five minutes of operation in gear with both rear wheels off the ground on a hoist.

   CAUTION: Never place the transmission in gear with the engine running when only one wheel of a limited slip differential equipped vehicle is raised. The vehicle might drive itself off the jack and cause damage or injury.

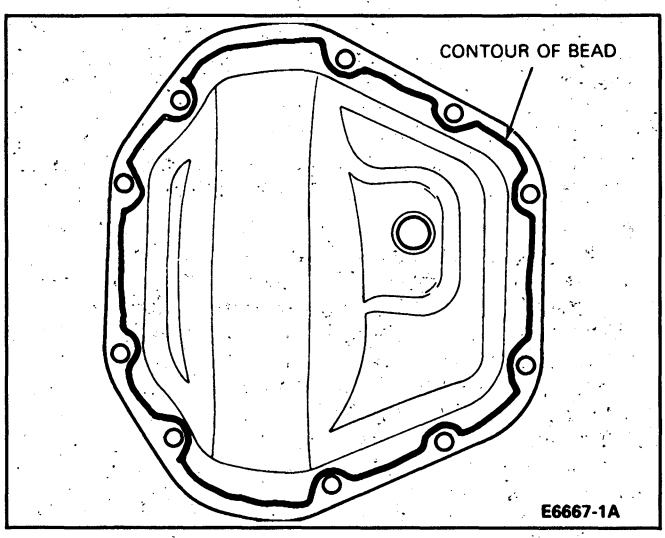


FIG. 5 Cover Plate—Flat Mounting Surface

2. Drain lubricant while warm. Remove cover plate to drain completely. If cover plate is removed, it will be necessary to replace gasket at this time.
3. Figure 5 shows the flat mounting surface cover plate on Dana design axles. This cover plate requires the use of Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent rather than a gasket.

   The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

   Apply Silicone Rubber E7TZ-19562-A (ESL-M4G273-A), or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

   The bead is to be 3.18-6.35mm (1/8 inch to 1/4 inch) wide.

   Assemble two cover screws into cover at 8 o'clock and 2 o'clock position. Use these two holes to guide cover plate into position on the carrier.

   Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lbs.).

   Allow one hour cure time before filling carrier with the proper amount of specified lubricant and vehicle operation.
4. Refill axle with specified lubricant.
5. Operate the vehicle for approximately 16 Km (10 miles), making at least ten figure eight turns to flush the old lubricant out of the clutch packs.
6. Repeat steps 2, 3 and 4, making sure to replace cover gasket, if required, in Step 2.
7. It is possible that a slight chatter, requiring additional vehicle operation may remain after Step 5. If chatter still persists after 160 Km (100 miles) of operation, or remains severe after Step 5 above, disassembly and repair will be necessary. See also the discussion of the special assembly sequence of the Model 70 Power-Lok under certain conditions under that paragraph of this Section.

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For further diagnostic and testing procedures refer to Section 15-01, General Driving Axle and Driveshaft Service.

REMOVAL AND INSTALLATION

For Dana Models 44-IFS, 44IFS-HD, 60, or 70 limited-slip differential rear axle Removal and Installation procedures, refer to Section 15-05 Integral Carrier Axle-Dana and Section 15-34, Front Driving Axle.

DISASSEMBLY AND ASSEMBLY

Dana Limited-Slip Axles

Service procedures for the Dana Model 60 and 70 axles with limited-slip differentials are covered separately in this Section.

The Dana limited-slip differential assembly is removed and installed in exactly the same manner as the conventional differential assembly. For these service procedures refer to Section 15-05 Integral Carrier Axle-Dana. Additive Friction Modifier, C8AZ-19B546-A, EST-M2C118-A or equivalent (friction modifier) is the only authorized additive which may be used with these axles.

When axle lubricant has been drained for front or rear axle repair (limited-slip only), refill the axle with the specified quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent and add 0.236L (eight ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles and 0.059L (two ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for front-drive axles.

Differential Case

Model 44IFS, 44IFS-HD, 60-1U 2-Pinion (Dana Trac-Lok)

Refer to Fig. 1.

Disassembly

The differential bearings need not be removed to overhaul the limited-slip differential, however, the ring gear will have to be removed first.

To remove and install the side gears, washers and clutch packs during disassembly and assembly requires special procedures and tooling.

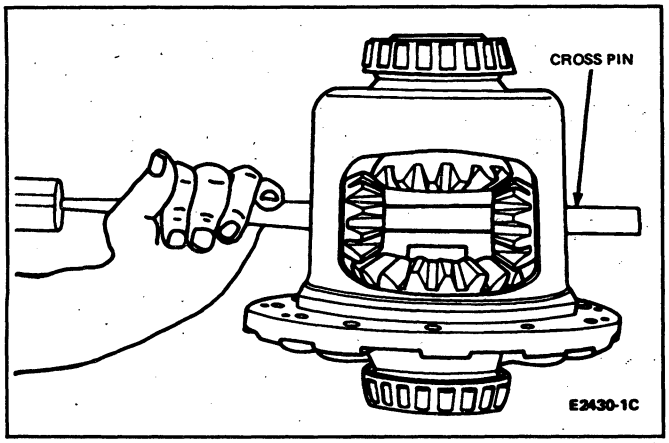


FIG. 6 Removing Cross Pin From Model 44IFS and 60-1U Axles

For Model 60 use, Limited-Slip Differential Tool D83T-4205-A.

An axle shaft placed in a vise, with the splines extending above the jaws of the vise not more than three inches, makes an excellent holding fixture after the case has been removed from the housing.

1. For Model 44IFS and 60-1U full float axles, use small drift to remove the roll pin retaining the cross pin. For Model 60-1U semi-float axles, a lock screw is used to secure the slip fit cross pin.
2. Remove the cross pin for the Model 44IFS and 60-1U full float axles with a hammer and drift (Fig. 6). The Model 60-1U semi-float cross pin is a slip fit and may be lifted out without tools.
3. Position the Step Plate, T83T-4205-A4 or equivalent, into the bottom side gear (Fig. 7). Apply grease to the centering hole of the Step Plate.

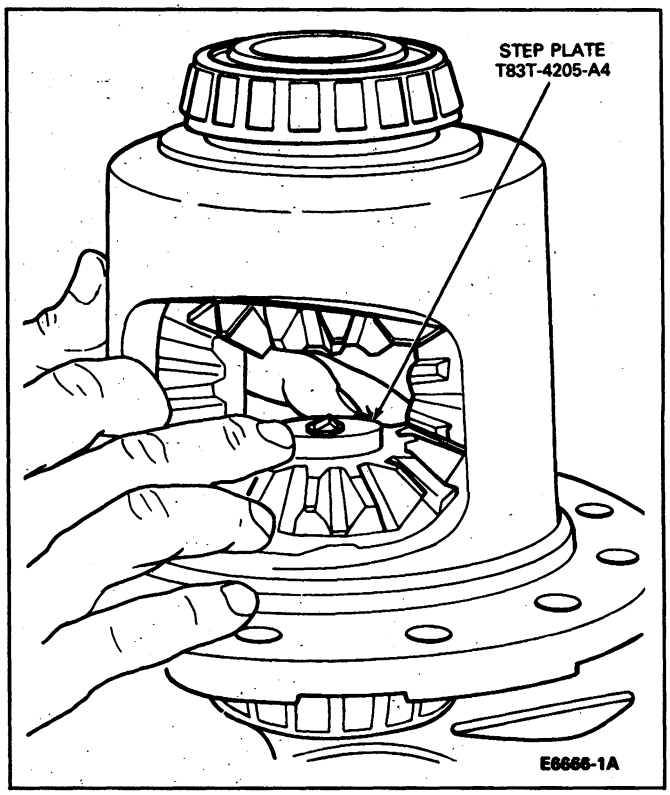


FIG. 7 Step Plate in Position

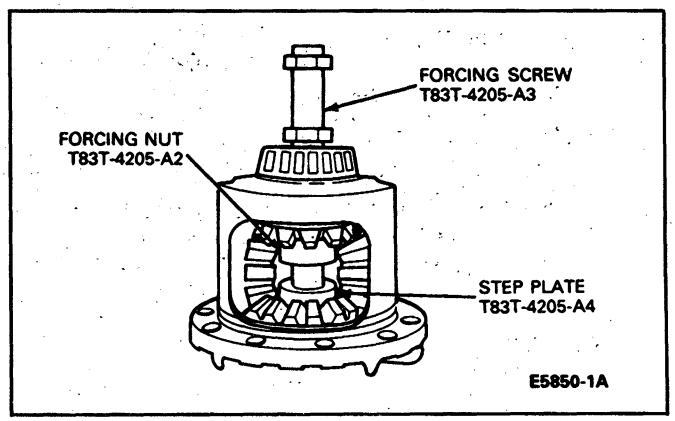


FIG. 8 Forcing Nut and Forcing Screw in Position

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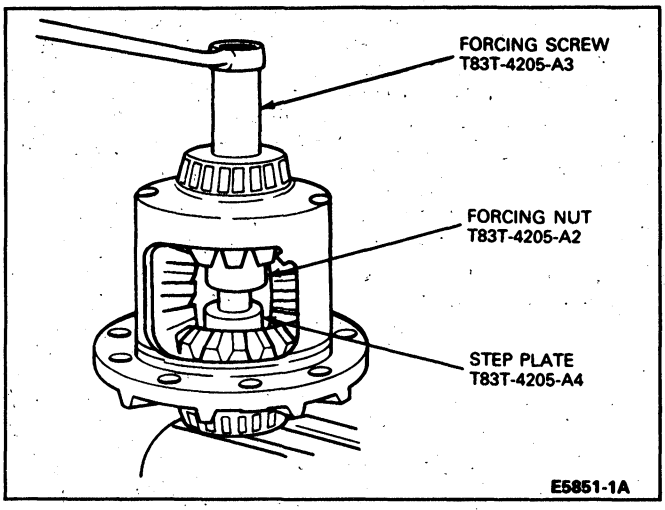


FIG. 9 Guiding Forcing Screw into Step Plate

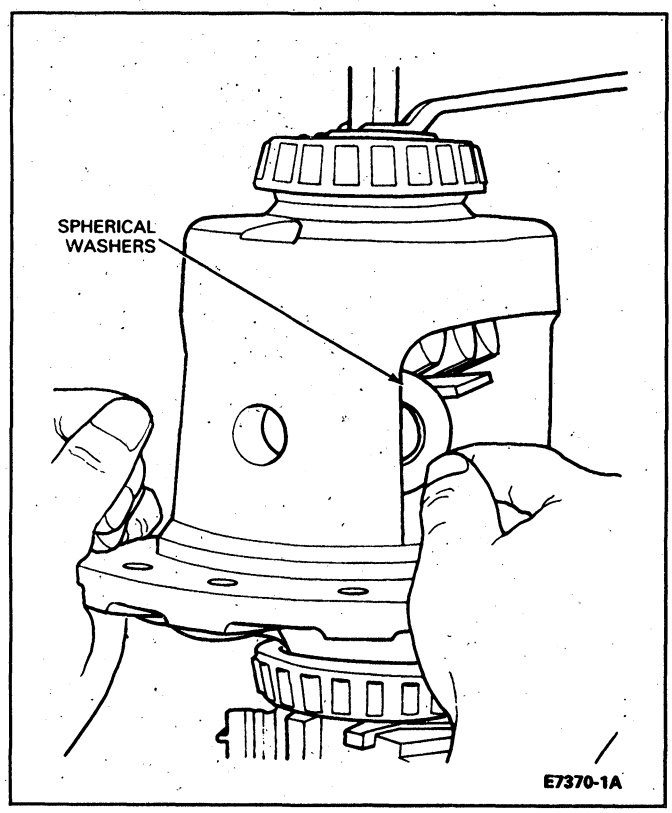


FIG. 10 Removing Spherical Washers

4. Install Forcing Nut T83T-4205-A2, and Forcing Screw T83T-4205-A3 or equivalents, into the differential case (Fig. 8).

5. Guide the forcing screw onto the step plate (Fig. 9).

6. Tighten the forcing screw tightly. This will move the side gears away from the differential pinion gears and relieve the normal loaded condition. Using a piece of 0.762mm (0.030 inch) thick shim or gauge stock, push out the differential spherical washers (Fig. 10).

7. Momentarily, loosen the forcing screw. This step is very important to relieve the pressure of the clutch pack.

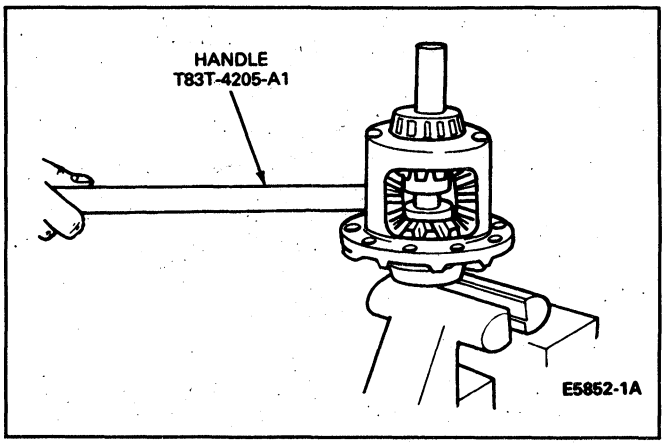


FIG. 11 Rotating Tool Handle in Position

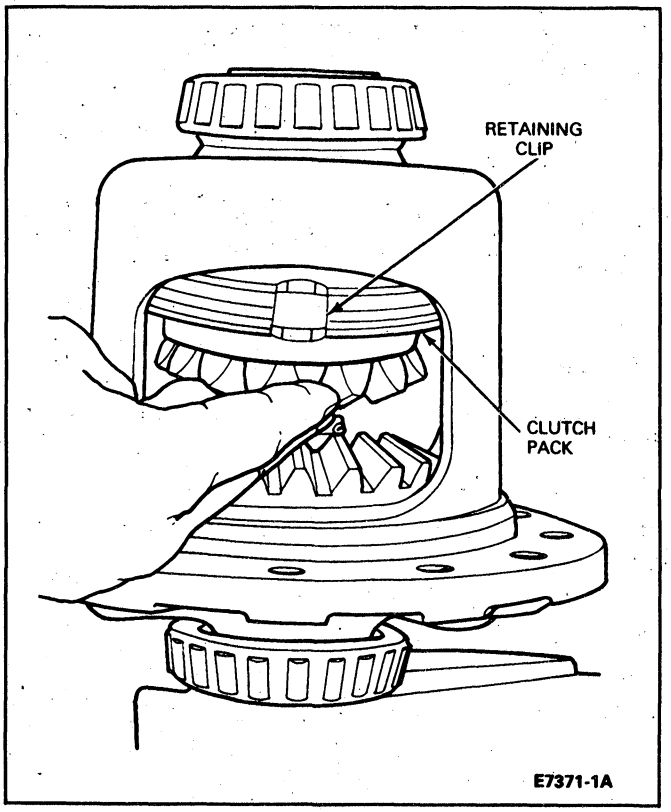


FIG. 12 Holding Clutch Pack

8. Re-tighten the forcing screw until a very slight movement of the differential pinion gears is seen.

9. Insert Handle T83T-4205-A1 or equivalent, into the pinion mate shaft bore and rotate the case (Fig. 11). Continue this until the differential pinion gears can be removed through the large openings in the case. When attempting to rotate the side gear, some tightening or loosening of the forcing screw will probably be required to permit the gear movement.

10. Retain the top side gear and clutch pack in the case with the hand and remove the forcing screw. Continue to hold the side gear and clutch pack and remove the gear rotating tool (Fig. 12). Remove the top side gear and clutch pack. Keep the stack of plates and discs in exact order.

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11. Turn this case so the flange, or ring gear side is up. As this is done, ease the step plate, side gear and clutch pack out of the case.
12. Remove the retainer clips from both clutch packs to allow separation of the discs and plates for cleaning and inspection. **Be sure to keep them in the exact order (Fig. 13).**

Assembly

1. Install the clutch packs, side gears and thrust washers. To do this, whether the original plates and discs or new ones are used, assemble them in exactly the same order as the originals. Always replace the entire kit of plates and discs even if only one component requires it. Refer back to illustrations used during disassembly for guidance in subsequent re-assembly operations.
2. Prelubricate the thrust face of the side gear and assemble the plates and discs to the side gear splines, prelubricating each part with Hypoid Gear Lubricant C6AZ-19580-A (ESW-M2C105-A) or equivalent or with Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier lubricant, both stacks.

CAUTION: If the discs are of the newer coated design (without concentric grooves), it is important to soak them for twenty minutes in Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) before assembly.

3. Assemble the retainer clips to the ears of the plates. Make sure both clips are completely assembled or seated onto the ears of the plates.

   With the differential case positioned as shown, assemble the clutch pack and side gear into the case. Make sure the clutch pack stays assembled to the side gear splines, and that the retainer clips are completely seated into the pockets of the case. To prevent the pack from falling out of the case, hold them in place by hand while re-positioning the case on a bench.
4. Re-position the case on the bench and assemble the step plate into the side gear. Apply a small amount of grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent into the centering hole of the step plate.
5. Assemble the other clutch pack and side gear. Make sure the clutch pack stays assembled to the side gear splines, and that the retainer clips are completely seated into the pockets of the case. Install Step Plate, T83T-4205-A4 or equivalent, on top of the side gear.
6. Hold the side gear in position by hand. Insert the Forcing Screw T83T-4205-A3 down through the top of the case, and thread Forcing Nut, T83T-4205-A2, on the screw. The tip of the Forcing Screw must contact the Step Plate.
7. With tools assembled to the case, position the case onto the axle shaft (as a holding fixture) by aligning the splines of the side gear with those of the shaft.
8. Position both differential pinion gears opposite one another through the openings in the case. Be sure the holes of the gears are lined up with each other. Hold the gears in place by hand.

   Tighten the forcing screw so that the side gears will move away from the differential pinion gears and relieve the loaded condition.
9. While holding the differential pinion gears in place, insert the Handle (T83T-4205-A1 or equivalent) into the pinion mate shaft. Pull on the handle so that the case will rotate and allow the differential pinion gears to rotate and enter into the case.

   As mentioned under Disassembly, it will probably be necessary to adjust the forcing screw by very slightly loosening or tightening it until the required load is applied to allow the side gear and differential pinion gears to rotate.
10. Rotate the case until the holes of both differential pinion gears are lined up exactly with those of the case.

    Prelubricate both sides of the pinion spherical washers with the specified lubricant, Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent.
11. Apply torque to the forcing screw to allow clearance to assemble the spherical washers.

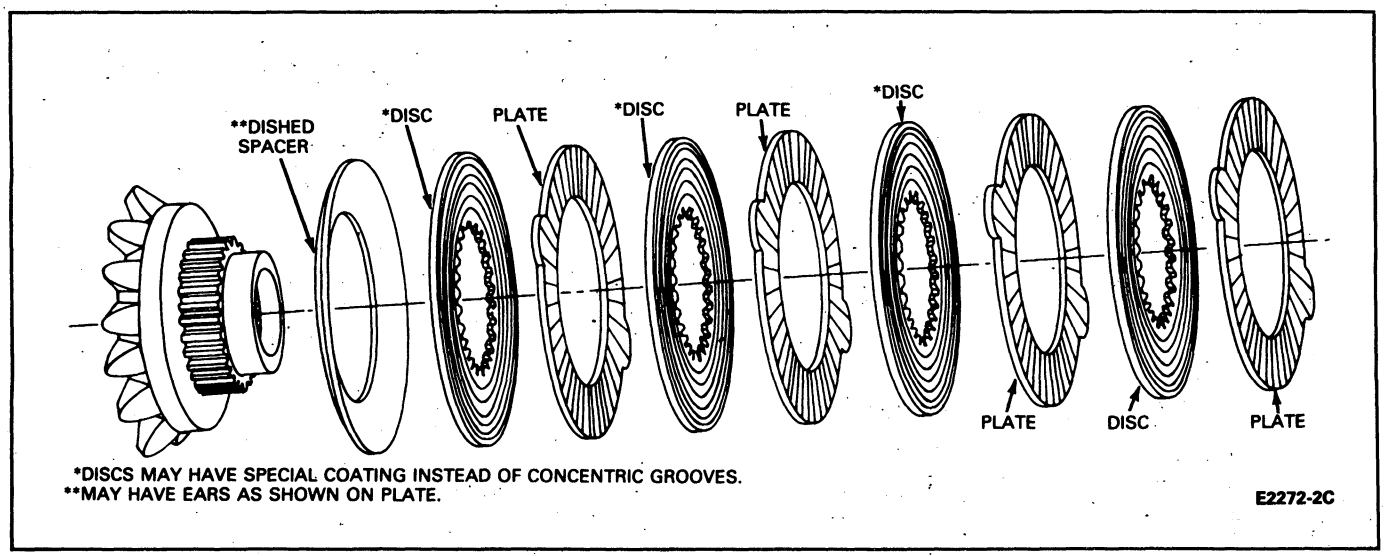


FIG. 13 Model 60-1U Plates and Discs to Side Gear—Exploded View

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CAUTION: Do not overtighten the forcing screw. Overtightening the forcing screw may damage the clutch plate and disc assemblies.

Assemble washers into the case. Use a very small screwdriver to push the washers into place. **Be sure the holes of the washers and gears are lined up exactly with those of the case.** Remove the forcing screw, forcing nut, handle, and step plate.

Install the pinion shaft in the differential case. Install the cross shaft locking pin.

12. Install the ring gear on the differential case, and tighten the attaching bolts to specification. Refer to Specifications in Section 15-05 Integral Carrier Axle-Dana.

Differential Case

Model 70 (4-Pinion) Power-Lok

Refer to Fig. 2 if the plates have radial grooves, or to Fig. 16 if then newer design with specially coated plates and a different configuration of dished plate and disc surfaces.

Disassembly

The differential bearings need not be removed to overhaul the limited-slip differential.

1. Mark the ring gear half and cover half of the differential case so that they can be re-assembled in the same relative positions. Mark the pinion mate shafts and their corresponding ramps so that they too can be re-assembled in the same positions (Fig. 14).
2. Clamp the differential assembly in a soft-jawed vise and loosen, but do not remove the bolts that hold the case halves together.
3. Place the differential assembly on the bench with the ring half of the case down. Remove the case attaching bolts, and then remove the cover half of the case (Fig. 15) on Model 70 differentials.
4. Remove the pinion mate gear, side gear ring, and clutch pack (Fig. 16). Keep these parts with the cover half of the case so that they can be re-installed in their original positions.
5. On Model 70 differentials, remove the corresponding parts from the drive gear half of the case.
6. On all models, clean all parts thoroughly and dry them with compressed air.
7. Inspect the clutch plates and discs for cracks, excessive wear, and distortion. If one or more of the plates, or discs need replacing, it is suggested that the entire stack of clutch plates on each side be replaced.

   Inspect all other parts and replace any part that appears to be worn or damaged (Fig. 17).
8. Inspect the pinion mate shaft surfaces and the ramp surfaces on the case for excessive wear or pitting.
9. Inspect the side gear and pinion gear teeth. Inspect the pinion gear races that bear on the side gear rings. Inspect the corresponding surfaces on the side gear rings.

Assembly

1. Place the side gear ring from the drive gear half of the case on a pinion flange (Fig. 18) or something similar, so that it is about four inches above the bench. Coat the clutch plates with axle lubricant, Hypoid Gear Lubricant, C6A-Z-19580-E (ESW-M2C105-A) or equivalent Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A).

CAUTION: If the plates are of the newer design (without concentric grooves), it is important to soak them for twenty minutes in Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) before assembly.

2. Refer to Fig. 16 and assemble the parts in the order indicated for the particular axle model being repaired.
3. Place the ring gear half of the case over the clutch pack and side gear ring. Make sure that the clutch plate lugs enter the slots in the case and that the case bottoms on the clutch pack (Fig. 18).
4. Grasp the flange and the case to hold the assembly together, and then turn the case half upside down.
5. Place the proper side gear in the side gear ring.

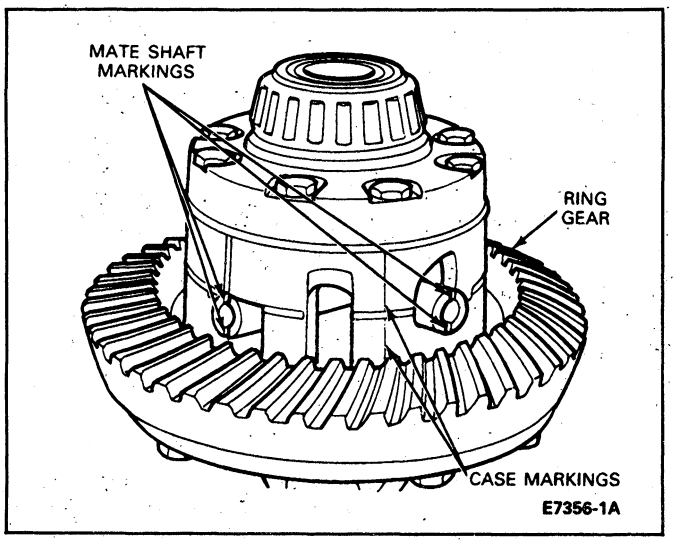


FIG. 14 Case and Mate Shaft Markings (Model 70)

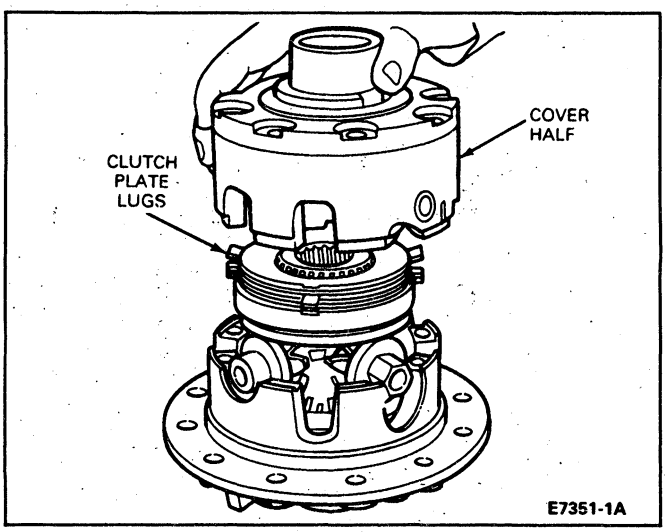


FIG. 15 Removing Cover Half of Case

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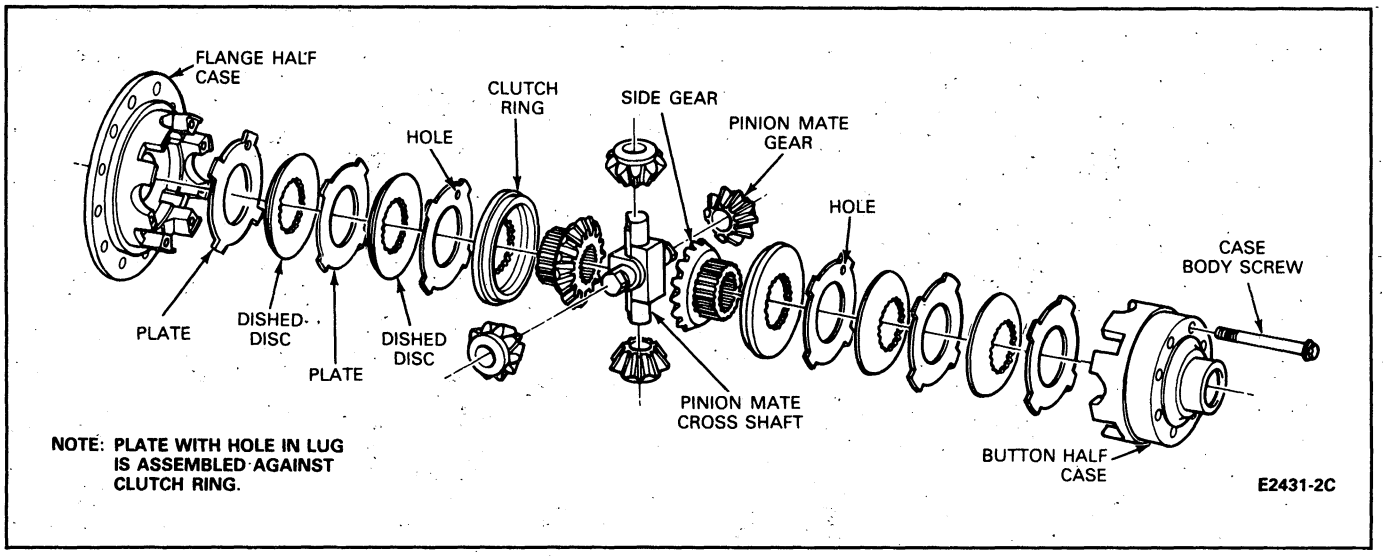


FIG. 16 Limited-Slip Differential (Model 70)—Exploded View. Design with Special Surface Coating on Plates, Two Dished Discs, and Flat Plates.

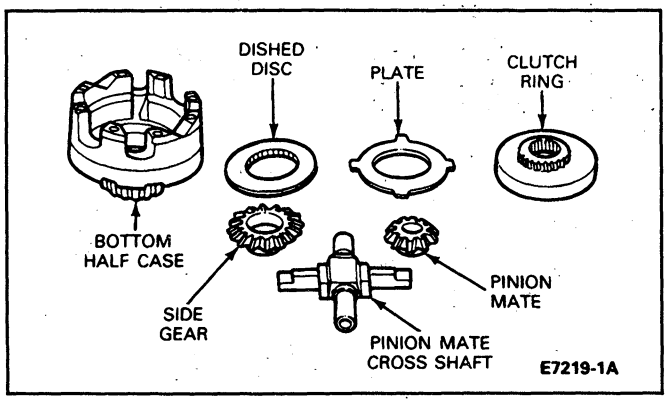


FIG. 17 Components to Check for Excessive Wear or Scoring

6. Place the mate shaft and pinions on the side gear ring (Fig. 19). Align the mate shaft and case markings.
7. Install the cover half mate shaft and pinions. Align the point markings.
8. Place the side gear on the pinions, and then place the side gear ring on the side gear and pinions.
9. Assemble the clutch pack on the side gear according to the arrangement shown in Fig. 20. Align the clutch plate lugs, and install all parts in the case.

NOTE: There may be circumstances of continuing chatter/bumping in turns despite replacement of parts and lubricant, particularly in vehicles operating at close to GVW rating. Typical situations are emergency vehicles and fifth wheel trailers. In these cases, it is permissible to re-assemble the clutch pack with the disc adjacent to the side gear ring, resulting in two plates together. This results in 3 friction surfaces instead of the normal 5, and will result in lowering the torque to rotate the wheel by 40%.

10. Place the cover half of the case over the assembly (Fig. 15). Align the case marks made before disassembly.
11. Install all the case bolts and turn each one on a few threads. Case bolts must be clean and dry.

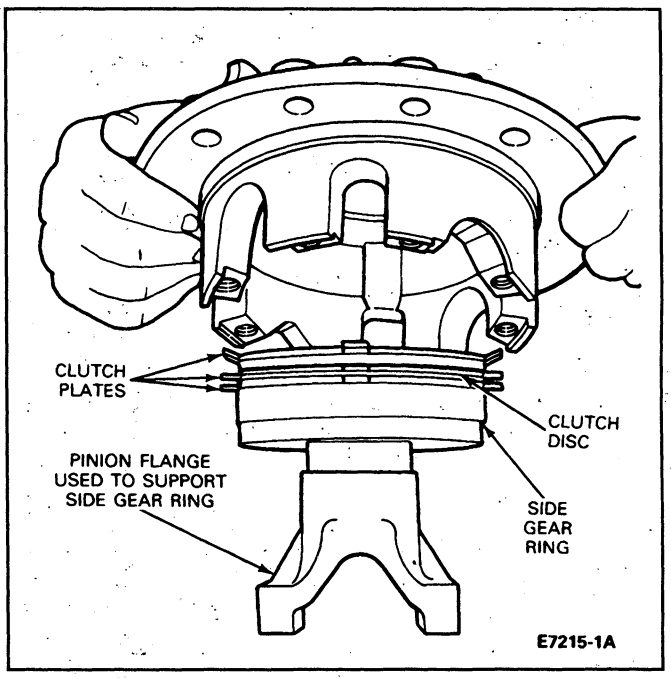


FIG. 18 Clutch Installed in Drive Gear Case Half—Model 70

Using both axle shafts, align the splines of the side gear and the side gear ring (Fig. 16) on both sides of the case. With the axle shafts in position, tighten the case bolts evenly and alternately to 89-94 N·m (65-70 ft-lb) (Fig. 21).

NOTE: If bolt heads have "180" or 7 radial lines stamped on head, tighten the case bolts to 122-136 N·m (90-100 ft-lbs)

12. Remove the axle shafts. **If the assembly has been properly assembled, each pinion mate cross shaft should be tight on its ramp; or, if there is clearance between the cross shaft and the ramp, it should be not more than 0.254mm (0.010 inch) and equal at all four cross shaft ends.**

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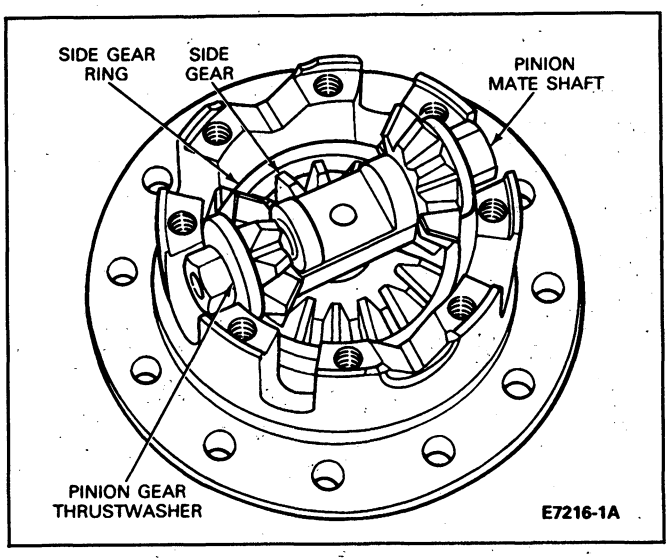


FIG. 19 Mate Shaft Installed—Model 70

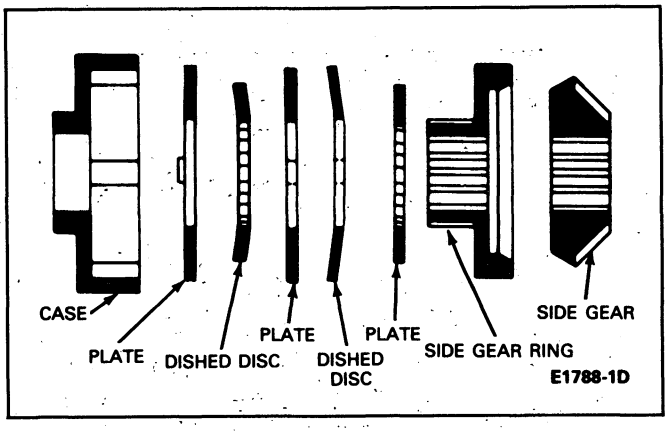


FIG. 20 Plate and Disc Arrangement—One Side of Model 70—Limited-Slip with Special Coated Plates and Two Dished Discs

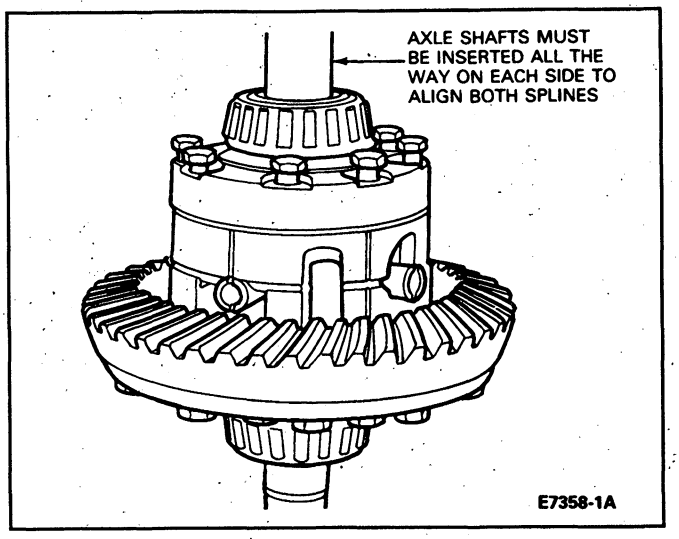


FIG. 21 Spline Alignment of Side Gear and Side Gear Ring

SPECIFICATIONS

Refer to Section 15-01, General Driving Axle and Driveshaft Service and Section 15-05, Integral Carrier Axle-Dana for Specifications.

SPECIAL SERVICE TOOLS

Number	Description	Application
TOOL-4000-E	Differential Housing Spreader	Dana 44,60 Axles
D83T-4205-A	Limited Slip Differential Tool	Dana 60 Axles
T83T-4205-A1	Limited Slip Differential Tool — Handle	Dana 60 Axles
T83T-4205-A2	Limited Slip Differential Tool — Forcing Nut	Dana 60 Axles
T83T-4205-A3	Limited Slip Differential Tool — Forcing Screw	Dana 60 Axles
T83T-4205-A4	Limited Slip Differential Tool — Step Plate	Dana 60 Axles
T53T-4221-C	Differential Side Bearing RPI.	Dana 60 Axles

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SECTION 15-43 Limited-Slip Differential—Ford—10.25 Inch Ring Gear

SUBJECT	PAGE
DESCRIPTION AND OPERATION	15-43-1
DIAGNOSIS AND TESTING	
Noise Acceptability	15-43-2
DISASSEMBLY AND ASSEMBLY	
Differential Case	15-43-3
REMOVAL AND INSTALLATION	
Differential Case	15-43-2
REMOVAL AND INSTALLATION	
Differential Bearings	15-43-10
SPECIFICATIONS	15-43-11
VEHICLE APPLICATION	15-43-1

VEHICLE APPLICATION

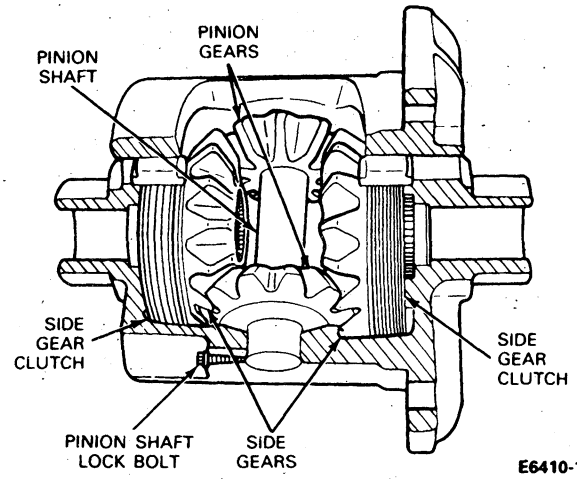
All F-250—F-350 Vehicles Equipped with Ford 10.25 Inch Ring Gear Axle and Limited-Slip Differential.

DESCRIPTION AND OPERATION

The Ford Limited-Slip Differential option is available on F-250-F350 vehicles with 10.25 inch ring gear rear axles.

The limited-slip assembly, except for the differential case and its internal components, is identical to the conventional axle. The limited-slip differential employs two sets of multiple-disc clutches to control differential action. The side gear mounting distance is controlled by 10 plates and 1 Belleville spring plate. The clutch pack consists of two plate designs: a splined plate that engages the splines of the side gear hub and alternate-tabbed or stationary plates.

LIMITED SLIP DIFFERENTIAL - CUTAWAY VIEW



DIAGNOSIS AND TESTING

NOTE: Refer to Section 12-31, Rear Antilock Brakes, for diagnostic and testing procedures regarding the excitor ring on the differential case on F-Series and Bronco vehicles equipped with rear Antilock brakes. For excitor ring service procedures, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear.

If roughness or noises such as chatter are present while turning corners, the probable cause is incorrect or contaminated lubricant.

Before a differential is removed and disassembled for chatter concerns, the lubricant level and grade should be determined.

Refill the axle with the specified quantity of Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent and add 0.237L (eight ounces) of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles. Warm the axle up and recheck for chatter by making a minimum of ten figure-eight type turns.

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DIAGNOSIS AND TESTING (Continued)

Noise Acceptability

A gear-driven unit (especially on a drive axle) will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions. For example, as on a newly paved blacktop road. The slight noise is in no way detrimental to the operation of the rear axle and must be considered normal.

NOTE: For vehicles equipped with a limited-slip differential a slight stick-slip noise on tight turns after extended highway driving is considered acceptable and has no detrimental effect.

If this is unsuccessful, a complete lubricant drain, flush and refill will usually correct chatter. The following procedure is recommended to ensure that the system is flushed of old lubricant:

1. Warm the lubricant by vehicle road operation or five minutes of operation in gear with both rear wheels off the ground on a hoist.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE IS DRIVEN BY THE ENGINE, THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK. ALWAYS BE SURE THAT BOTH WHEELS ARE OFF THE GROUND.

2. Drain lubricant while warm. Remove cover to drain completely. If cover is removed, it will be necessary to replace gasket at this time.
3. Clean the gasket mating surface of the rear axle carrier casting and cover.

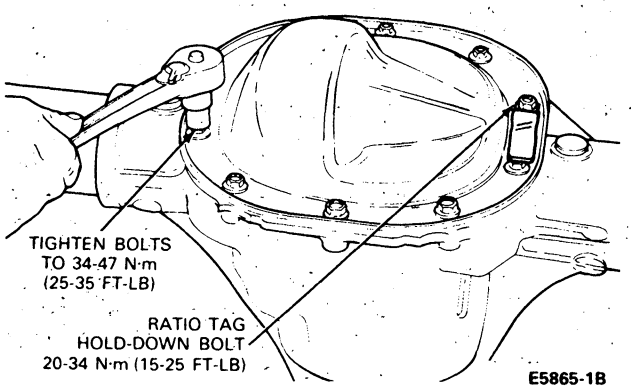
   Apply a new continuous bead of Silicone Rubber (D6AZ-19562-AA or equivalent) to the carrier casting face inside the cover bolt holes.

CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.

4. Install cover and tighten cover bolts to 34-47 N·m (25-35 ft-lb) as shown. Tighten the cover bolts in a cross-wise pattern to insure uniform draw on cover.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.

5. Add lubricant through the fill hole until the lubricant level reaches the bottom of the fill hole with the axle in the running position (approximately 6.5 U.S. pints). For out-of-vehicle repairs, add 7.5 U.S. pints of lubricant. Install the fill plug and tighten to 20-41 N·m (15-30 ft-lb).



6. Operate the vehicle for approximately 16 km (10 miles), making at least ten figure-eight turns to flush the old lubricant out of the clutch packs.
7. Repeat Steps 2, 3, 4 and 5, making sure to replace cover gasket.
8. It is possible that a slight chatter, requiring additional vehicle operation may remain after Step 5. If chatter still persists after 160 km (100 miles) of operation, or remains severe after Step 6 above, disassembly and repair will be necessary.

For further diagnostic and testing procedures refer to Section 15-01, General Driving Axle Service.

REMOVAL AND INSTALLATION

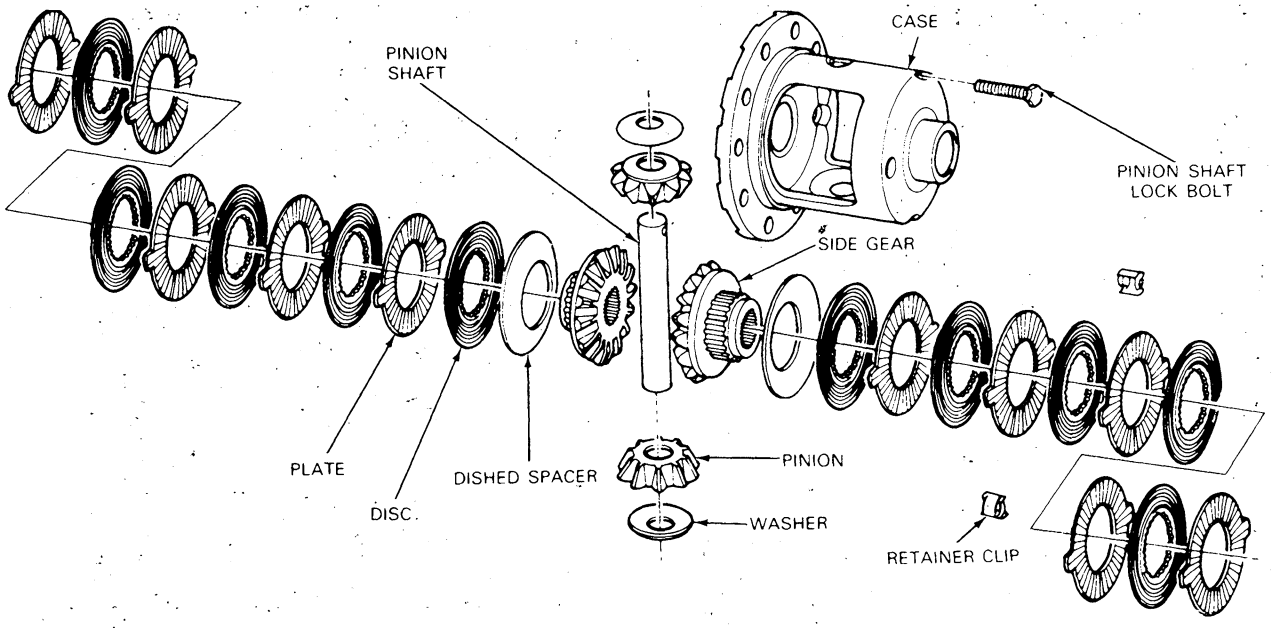
Differential Case

For Removal and Installation Procedures, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear.

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DISASSEMBLY AND ASSEMBLY

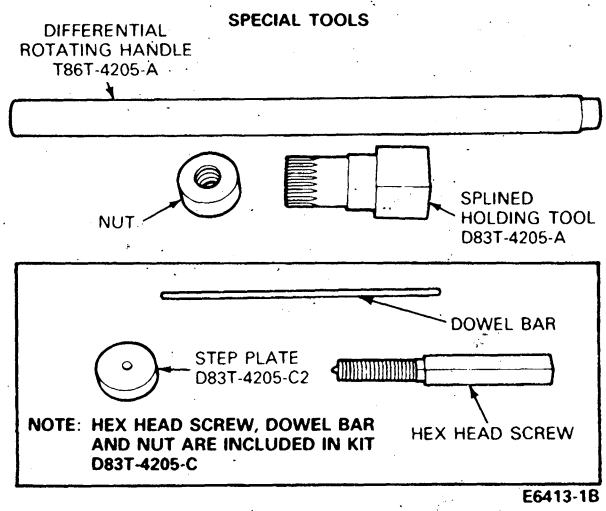
Differential Case



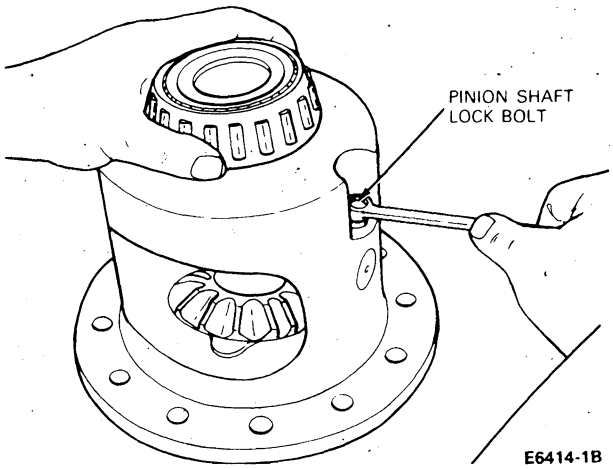
Disassembly

NOTE: The differential bearings need not be removed to overhaul the Ford Limited-Slip Differential. If bearing removal is required, refer to Differential Bearings—Removal and Installation in this Section. Removal and installation of the side gears, clutch packs, pinion gears and thrust washers require special procedures and tools as described below.

SPECIAL TOOLS



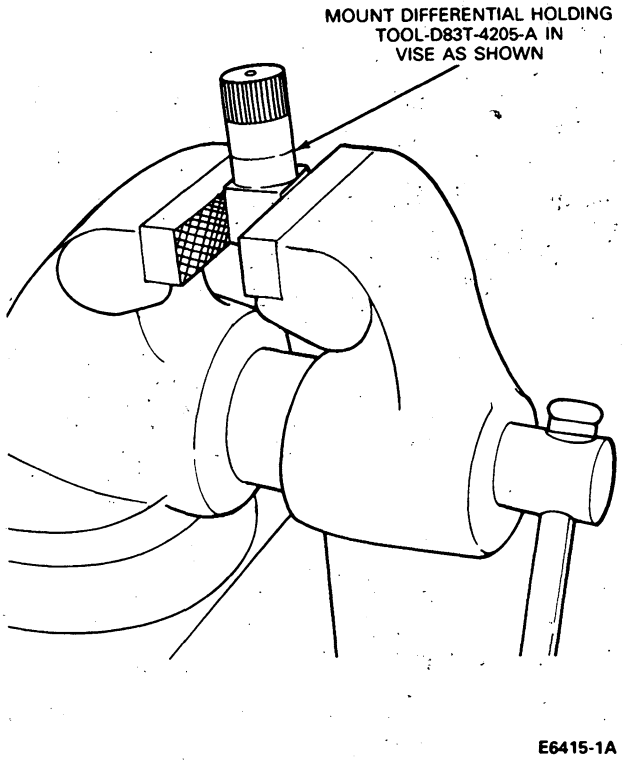
1. Remove the differential pinion shaft lockbolt.



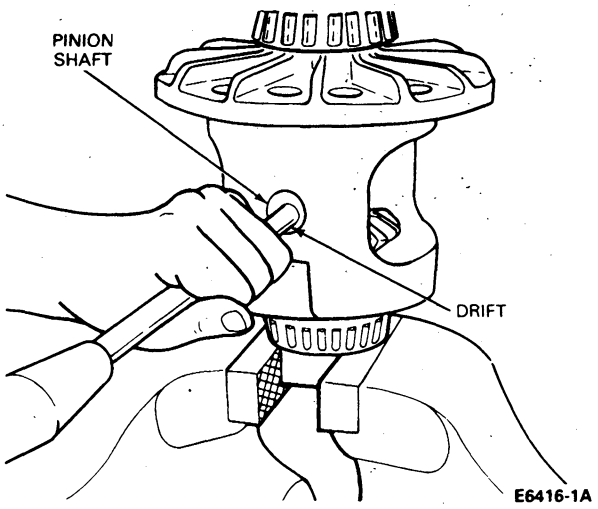
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DISASSEMBLY AND ASSEMBLY (Continued)

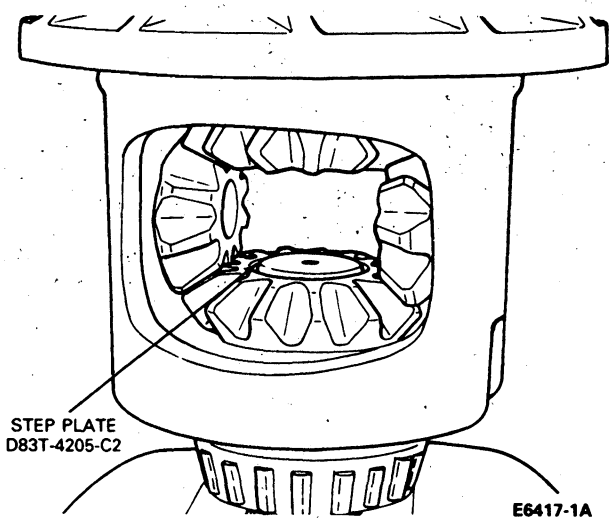
2. Install differential assembly Holding Tool, D83T-4205-A, in a suitable vise. Install differential assembly in the vise with the ring gear side facing up.



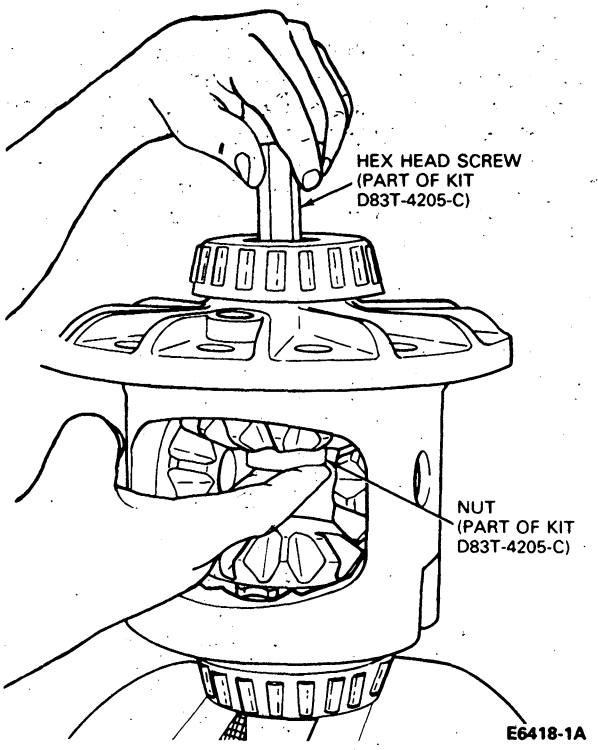
3. With a hammer and drift, drive the pinion shaft from the differential case.



4. Install Step Plate, D83T-4205-C2, in bottom side gear bore. Apply a small amount of grease to centering hole of the step plate.



5. Install nut in upper side gear. Hold nut in position while installing Hex Screw Tool (part of D83T-4205-C).

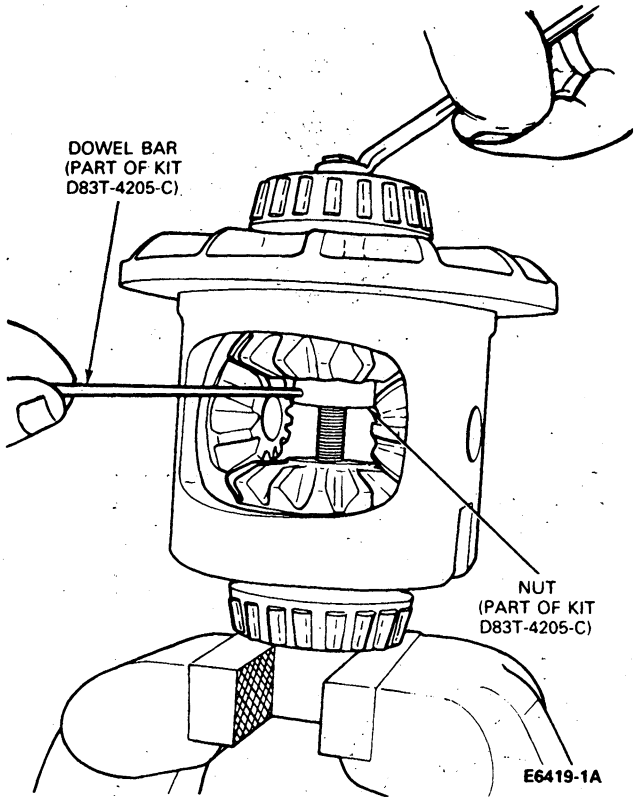


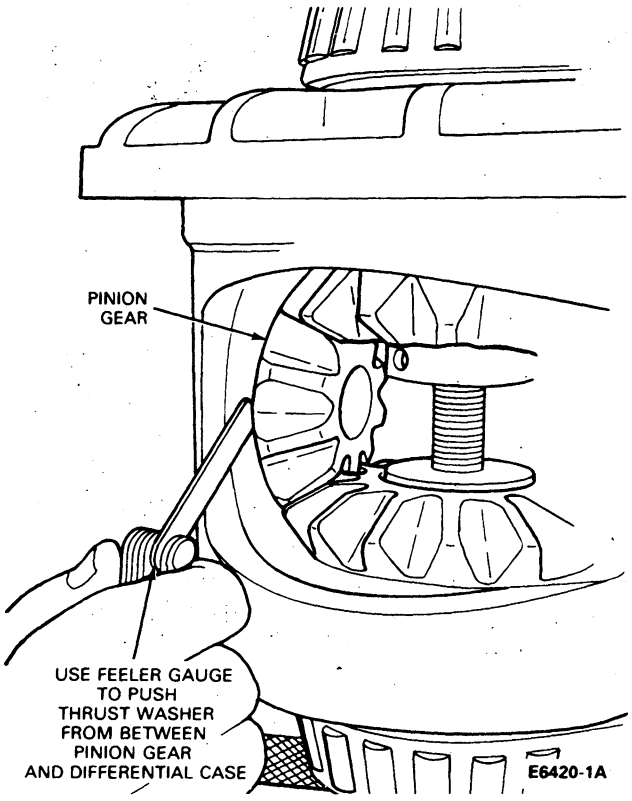
6. Insert Dowel Bar or equivalent, part of D83T-4205-C, in hole of nut. Tighten forcing screw to force side gears away from the pinion mating gears. The dowel bar is used to keep the nut from turning when the forcing screw is tightened.

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DISASSEMBLY AND ASSEMBLY (Continued)

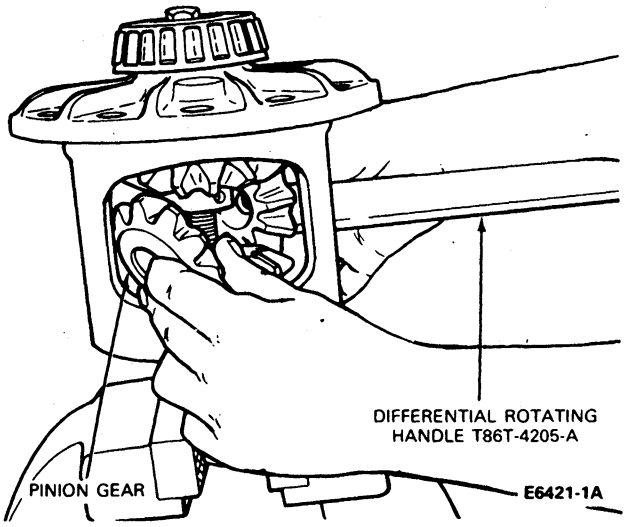
7. With an appropriate size feeler gauge, push the pinion gear thrust washers out from between the pinion gears and the differential case. Remove the thrust washers, then back off the forcing screw until it is loose (approximately one turn).





8. Insert Rotating Tool T86T-4205-A in the pinion shaft bore and turn the case to "walk" the pinion gears out to the differential case windows. Remove the pinions.

NOTE: Make sure vise is tightened securely during this Step.

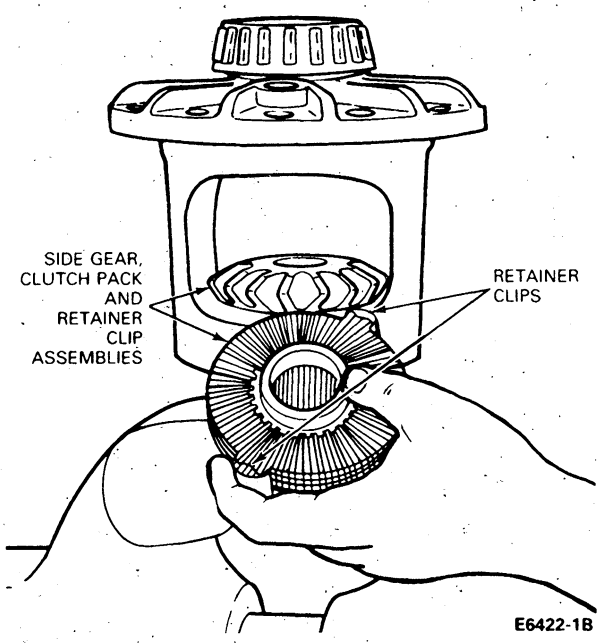


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DISASSEMBLY AND ASSEMBLY (Continued)

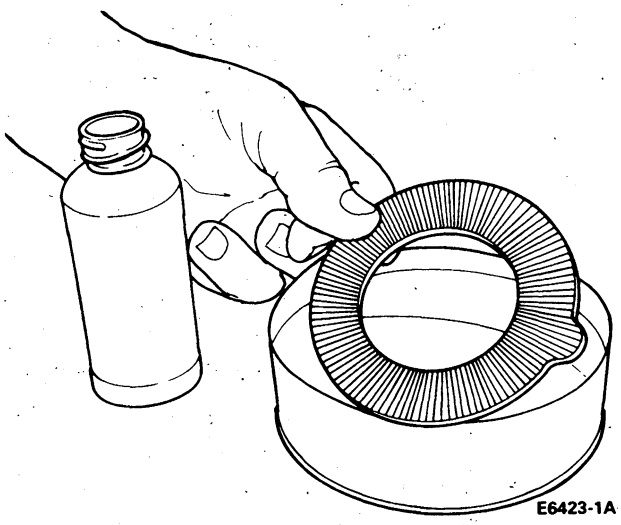
9. Remove the forcing screw and step plates. Remove the side gears, retainer clips and clutch pack assemblies.
10. Remove the retainer clips from both clutch packs to allow separation of the discs and plates for cleaning and inspection. Refer to the exploded view at the beginning of this procedure.

CAUTION: When separating the clutch plates and discs, note the sequence in which they are disassembled. They must be reassembled in the same sequence.



Assembly

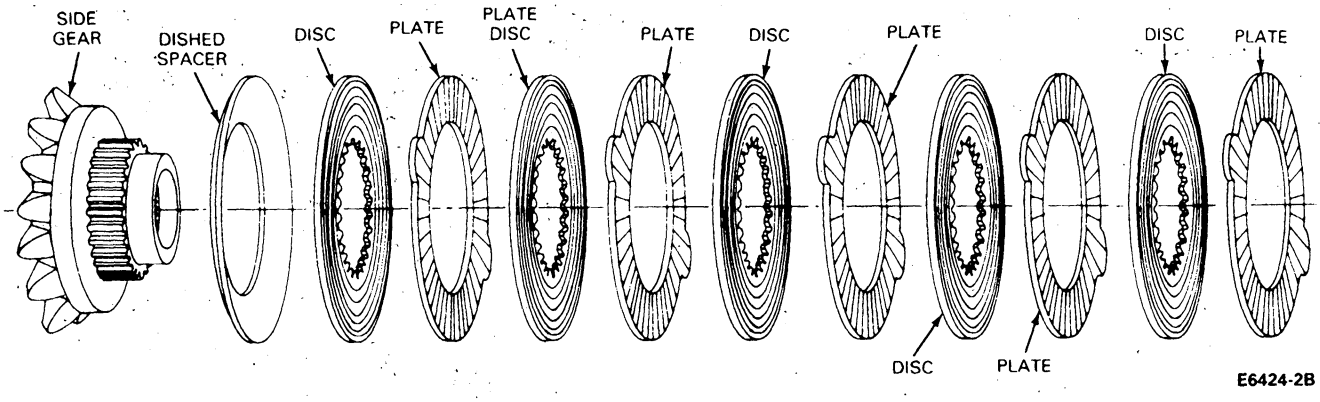
1. Prelubricate each disc and plate with Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A), or equivalent friction modifier lubricant.



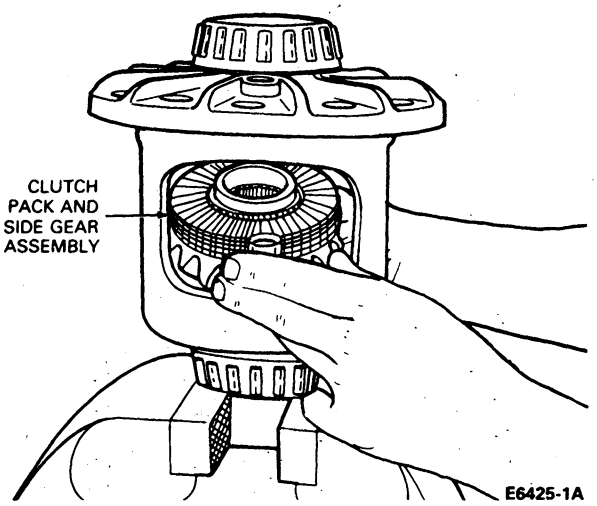
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DISASSEMBLY AND ASSEMBLY (Continued)

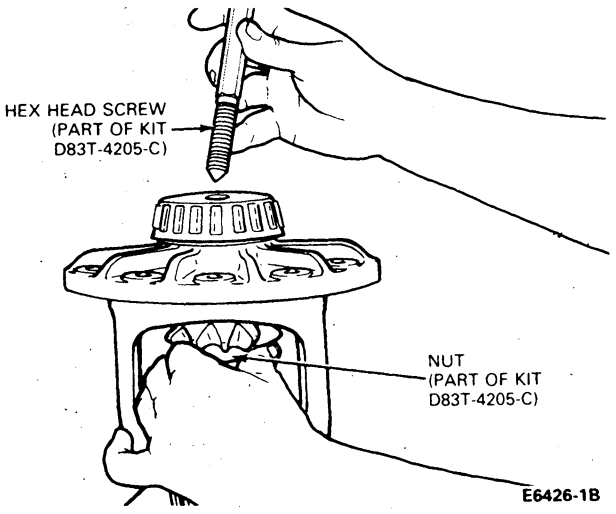
2. Prelubricate the thrust face of the side gear. Assemble the plates and discs to the side gear splines in exactly the same sequence in which they were removed. Assemble the retainer clips to the ears of the plates. Make sure both clips are completely assembled and seated onto the ears of the plates.



3. Install Differential Holding Tool, D83T-4205-A in a suitable vise. Place differential case on holding tool with ring gear side facing up. Insert the clutch pack and side gear assemblies into the differential case. Make sure that the clutch packs stay assembled to the side gear splines, and that the retainer clips are completely seated in the pockets of the differential case. Hold the upper clutch pack and side gear assembly in place to prevent it from falling out of the differential case.

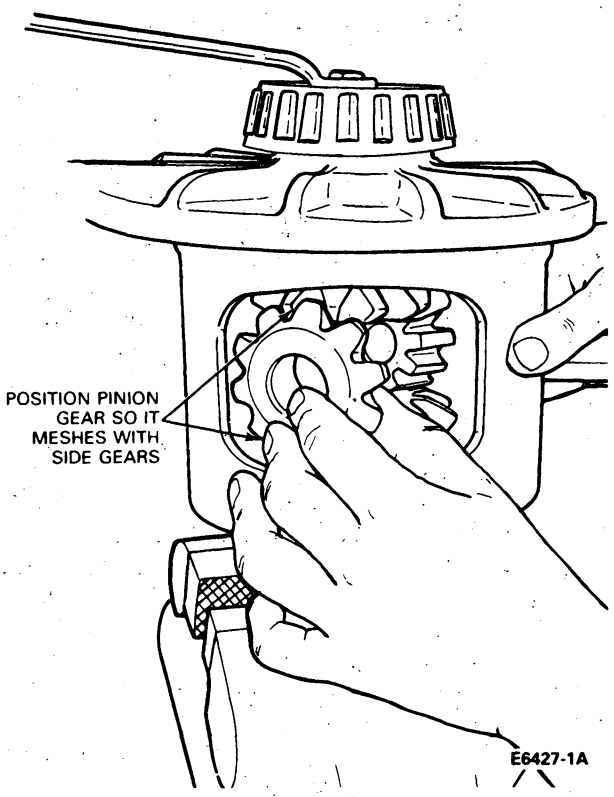


4. Position Step Plate, D83T-4205-C2, in the bottom side gear bore. Apply a small amount of grease to the step plate bore. Position nut, part of D83T-4205-C, in the top side gear bore and hold it in place. Install the Hex Screw Tool, part of D83T-4205-C, and tighten it two turns after it contacts the bottom step plate. Insert the Dowel Bar or equivalent, part of D83T-4205-C, in nut bore to keep the nut from turning as the hex screw is tightened.
5. Position the pinion gears in the window of the differential case so that they mesh with the side gear teeth. Hold the pinion gears in place. Make sure that the pinion gears are 180° apart so they will correctly align with the pinion shaft bore.



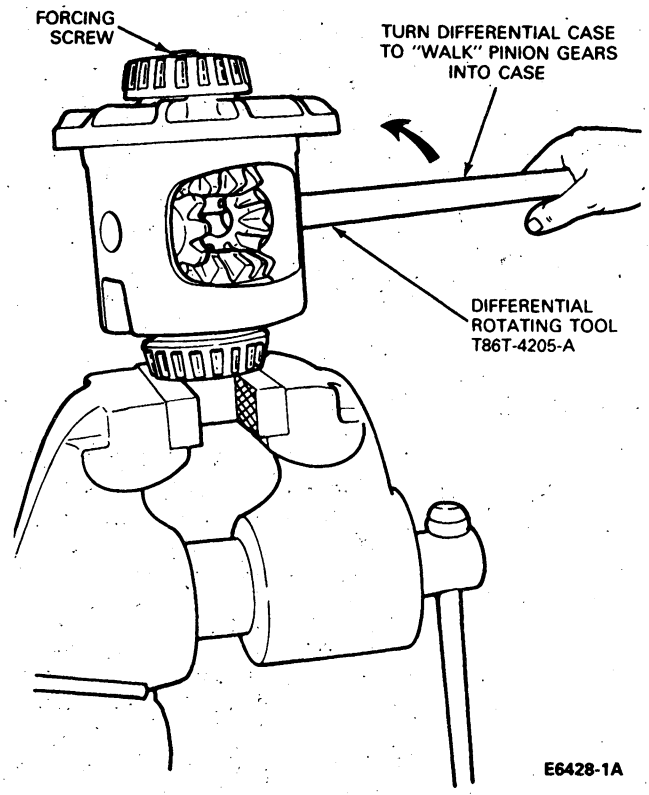
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DISASSEMBLY AND ASSEMBLY (Continued)



6. Insert the Rotating Tool, T86T-4205-A, into the pinion shaft bore and turn the differential case. This will cause the pinion gears to engage the side gears and "walk" into the differential case. Rotate the differential case until the pinion mating shaft holes are lined up exactly with the holes in the pinion gears.

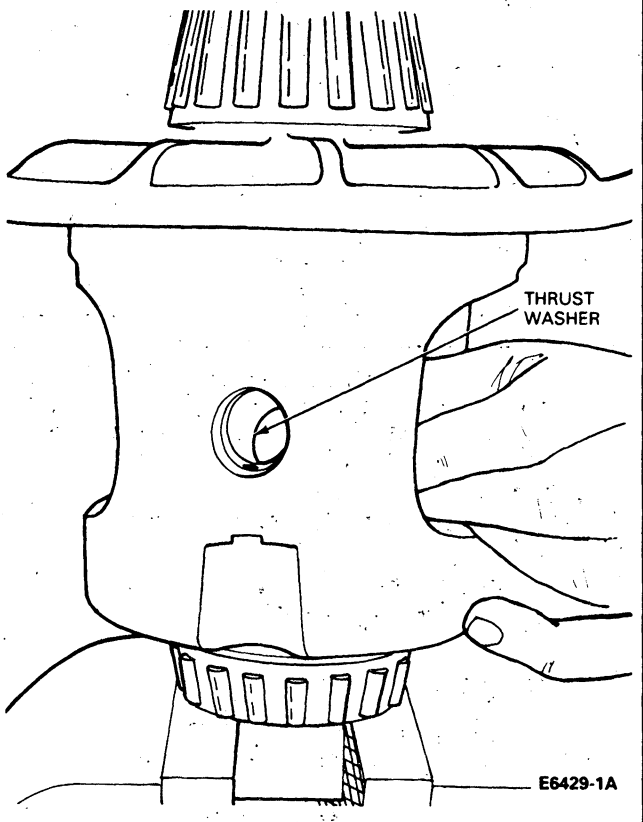
NOTE: It will probably be necessary to loosen or tighten the forcing screw to allow the pinions and side gears to rotate.



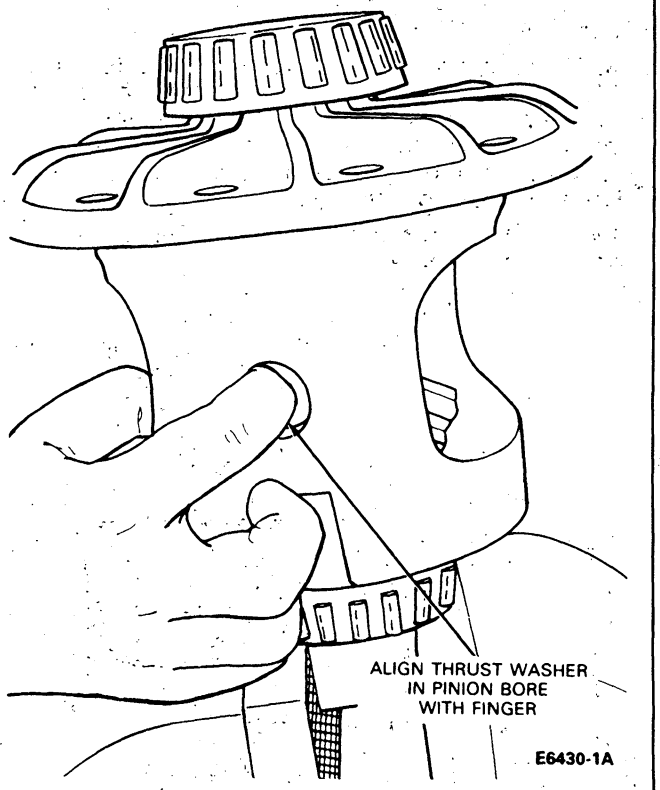
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DISASSEMBLY AND ASSEMBLY (Continued)

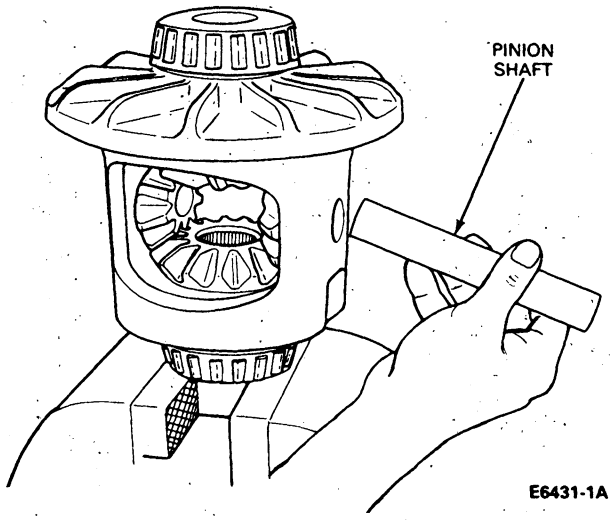
7. Prelubricate both sides of the pinion thrust washers with Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent. Apply torque to the forcing screw to allow clearance to insert the thrust washers. Insert the pinion gear thrust washers between the pinion gears and the differential case with the concave side facing in.



8. Be sure to align the thrust washer holes with the bore in the differential case PRIOR to installing differential pinion shaft.



9. Loosen the forcing screw and remove the step plate and nut from the side gear bores. Install the pinion shaft in the differential case. Install the pinion shaft lock bolt and tighten to 20-40 N·m (15-30 ft-lb).
10. If removed, install the ring gear on the differential case and tighten the attaching bolts to specifications. For detailed procedures and specifications, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear.



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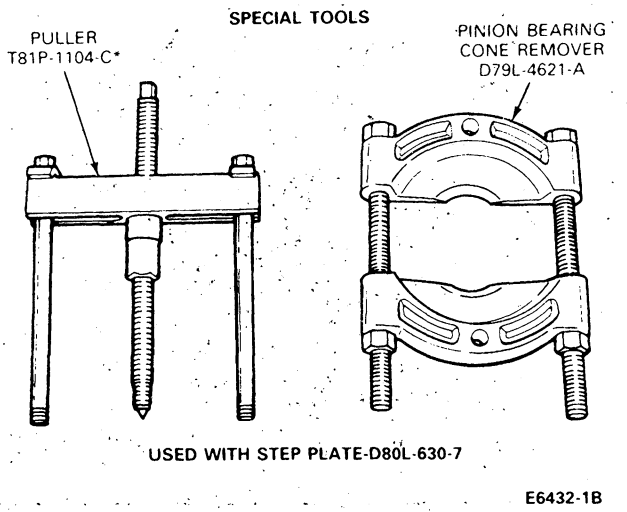
REMOVAL AND INSTALLATION

Differential Bearings

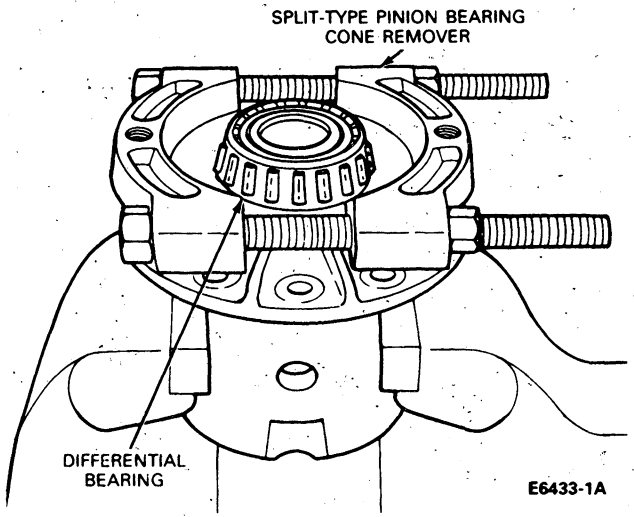
Removal

NOTE: It is not necessary to remove the differential bearings as a part of the differential case disassembly procedure. However, the following procedure assumes that the differential side gears, clutch packs and pinion gears are removed from the differential case prior to removing the bearings.

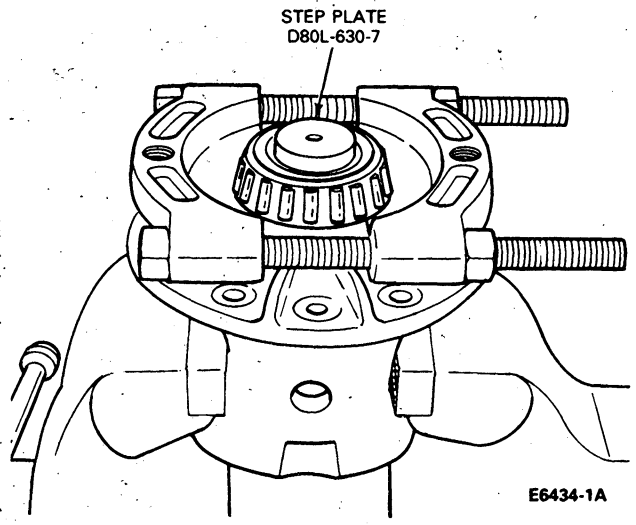
NOTE: Differential bearing removal requires special tools and procedures.



1. Mount the differential case in a vise. Use brass pads on vise jaws to prevent damage. Mount split-type Pinion Bearing Cone Remover D79L-4621-A on the differential case. Tighten bolts on puller to separate the bearing cone from the case face.



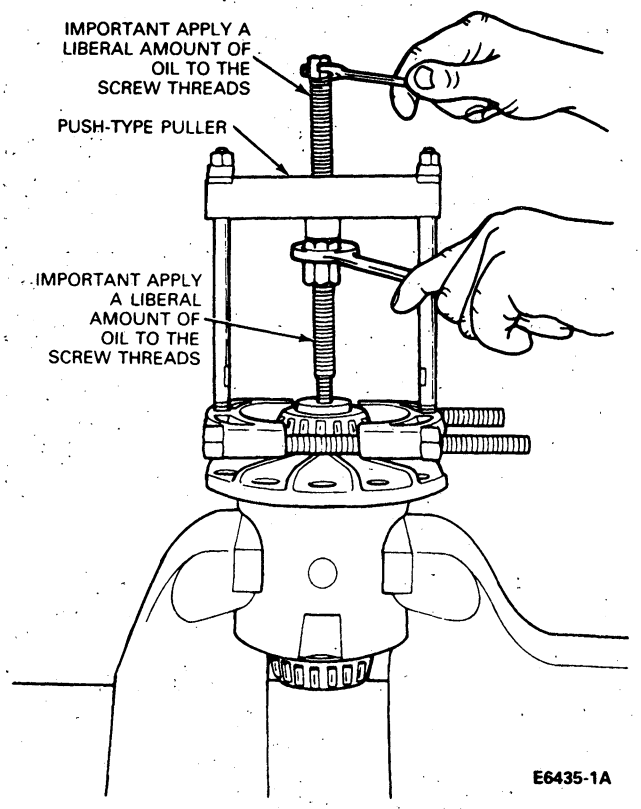
2. Place step plate (available as part of Step Plate Set D80L-630-7) on bearing inner cone. Apply a small amount of grease to the step plate bore.



3. Mount push-type Puller T81P-1104-C on the bearing cone remover, making sure that the puller shaft seats in the bore of the step plate. Pull the bearing off the differential case.

CAUTION: It is extremely important to apply a liberal amount of oil to the screw threads of Tool T81P-1104-C.

NOTE: Replace bearings whenever they are removed from the differential.



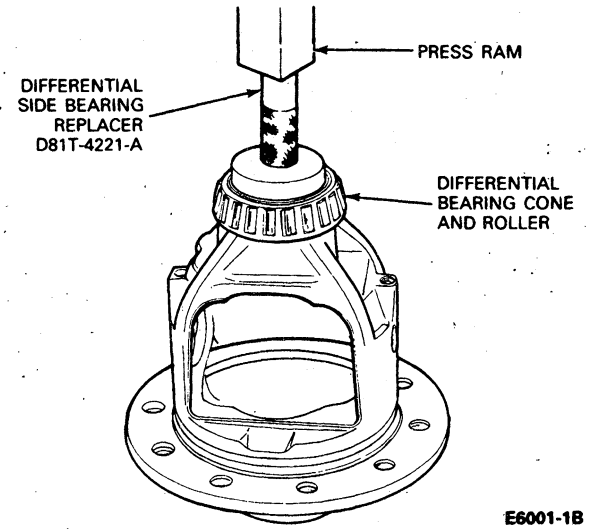
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REMOVAL AND INSTALLATION (Continued)

Installation

1. Install differential bearings on the case hubs using Differential Bearing Cone Replacer, D81T-4221-A.

NOTE: Press against the bearing cone only.



E6001-1B

SPECIFICATIONS

Refer to Section 15-01, General Driving Axle Service and Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear for specifications.

SPECIAL SERVICE TOOLS

Tool Number	Description
T86T-4205-A	Differential Rotating Handle
D83T-4205-A	Splined Holding Tool
D83T-4205-C	Differential Service Kit Kit includes: Hex Head Screw Dowel Bar Nut
D83T-4205-C2	Step Plate
D79L-4621-A	Pinion Bearing Cone Remover
D80L-630-7	Step Plate
D81T-4221-A	Differential Bearing Cone Replacer
T81P-1104-C	Front Hub Remover/Replacer

CE6529-1D

LIMITED-SLIP DIFFERENTIAL IDENTIFICATION

Identification Tag	Ratio
111C	4L10:1
131C	4L10:1
132C	4L10:1
169C	4L10:1
171C	4L10:1
191C	4L10:1
192C	4L10:1

CE7662-1B

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER)

Vehicle	Axle	Approximate Lubricant Capacity (In-Vehicle Repair)①②		
		U.S. Pints	Imperial Pints	Liters
F-250, F-350 Regular & Chassis CAB, F-250/350 H.D.	10-1/4 Inch Ring Gear	6.5③④	5.4	3.0

① All conventional Axles use Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent.
② For out-of-vehicle repair, use 7.5 U.S. Pints (6.2 imperial pints, 3.5 Liters)
③ Below bottom of filler hole with vehicle in running position.
④ Plus 8 oz. (U.S. measure) additive friction modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent for limited-slip applications.

CE6524-2B

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SECTION 15-60 General Driveshaft Service

SUBJECT	PAGE
ADJUSTMENTS	
Alternate In Vehicle Driveshaft Balancing Procedure	15-60-16
Driveshaft Balancing	15-60-14
DESCRIPTION	
Front Driveshaft	15-60-2
Rear Driveshaft	15-60-1
DIAGNOSIS AND TESTING	
Coupling Shaft/Center Bearing Alignment	15-60-10
Diagnosis Guides	15-60-13
DIAGNOSIS AND TESTING (Cont'd.)	
Driveline Angularity	15-60-6
Driveline Vibration	15-60-3
Rear Axle Companion Flange Runout Check	15-60-11
Slip Yoke Spline	15-60-11
Two-Piece Driveshaft Service	15-60-10
U-Joint Phasing	15-60-5
SPECIFICATIONS	15-60-18
VEHICLE APPLICATION	15-60-1

VEHICLE APPLICATION

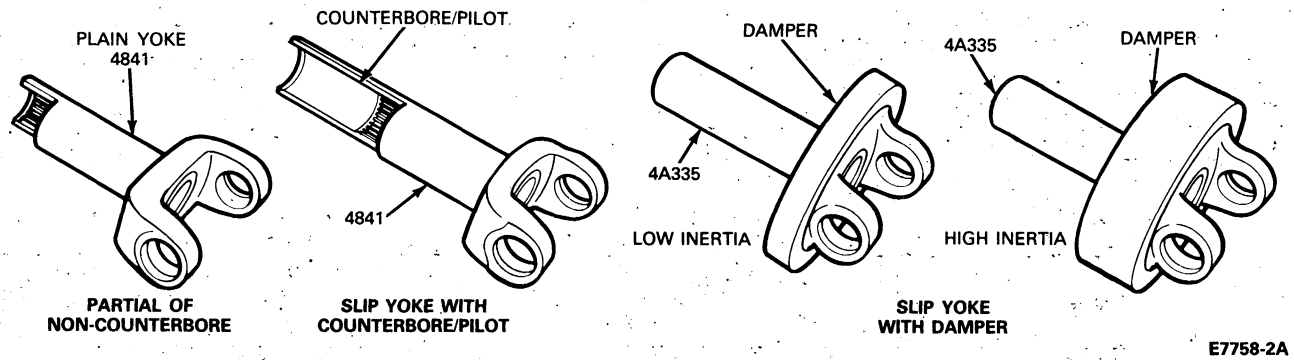
All E-150—E-350, F-150—F-350 (4x2/4x4), F-Super Duty and Bronco Vehicles.

DESCRIPTION

Rear Driveshaft

The driveshaft or coupling shaft is composed of the universal joints (U-joints), connecting shafts, attaching flanges, and slip yokes. The number of shafts and U-joints used depends on the vehicle application.

Some vehicles use a one piece steel or aluminum, slip-yoke type driveshaft. A universal joint and splined slip yoke are located at the transmission end of the shaft, where they are held in alignment by a bushing in the transmission rear extension. The splined slip yoke and transmission output shaft allow fore and aft movement of the driveshaft as the rear axle moves up and down. This provides smooth performance during vehicle operation. An oil seal at the transmission prevents leakage and protects the slip yoke from dust, dirt and other harmful material. A second universal joint attached by two U-bolts is used where the driveshaft mates with the companion flange at the rear or an axle flange yoke on vehicles equipped with circular axle flange.



Others use a coupling shaft in conjunction with a driveshaft. Care must be taken to align the shafts as shown in the figures. The two-piece driveline system incorporates a "necked down" coupling shaft stub with a "blindspline" feature which assures positive phasing action.

All two piece driveshaft vehicles are equipped with center support bearings that are prelubricated and sealed for the bearing life.

All U-joints are of the lubed for life needle-bearing type. U-joints equipped with grease fittings should be lubricated at the specified intervals. The U-joint bearings are retained on the U-joint spiders by snap rings and U-bolts on some applications.

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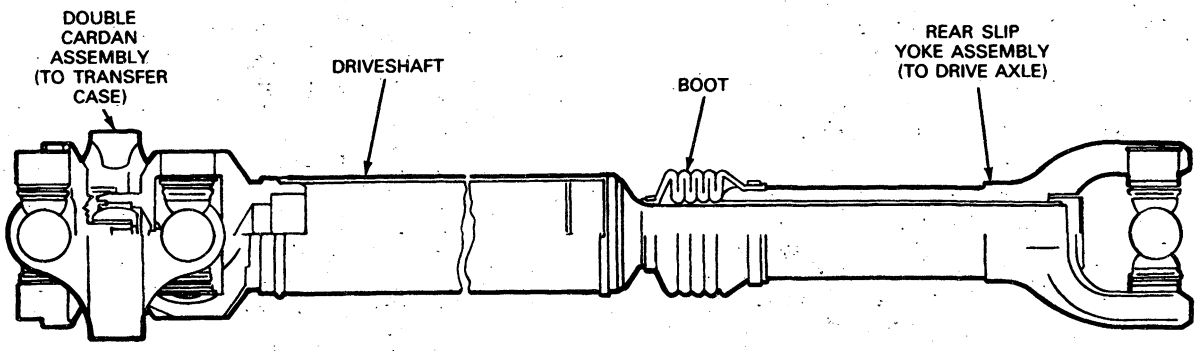
DESCRIPTION (Continued)

All driveshafts and coupling shafts are balanced; therefore, if the vehicle is being undercoated, the shafts and all open spline areas must be covered to prevent undercoating material from getting on the shafts.

Three types of driveshaft connecting joints are available on different vehicles, they are:

1. Single Cardan U-Joint.
2. Double Cardan U-Joint.
3. Constant Velocity Joint.

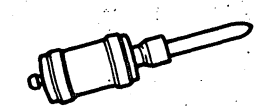
The Bronco rear driveshaft assembly is of the double Cardan type which incorporates two U-joints, a centering socket yoke, and a center yoke at the transfer case end of each shaft. A single U-joint is used at the axle end of the shafts.



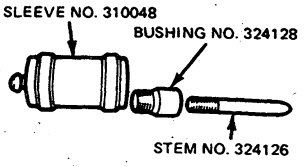
E7158-2A

There is only one flush type fitting for the centering device. The slip yoke only has one lube fitting. U-joints equipped with grease fittings should be lubricated at the specified intervals. They should be lubricated periodically with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

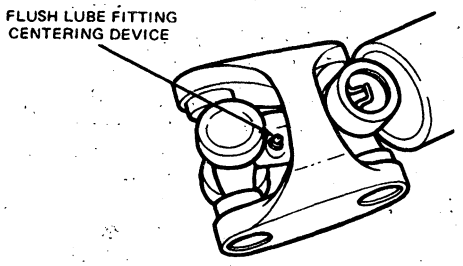
CAUTION: Under no circumstances is the driveshaft assembly to be clamped in the jaws of a vise or similar holding fixture. Denting or localized fracture of the tube may result, which could cause driveshaft failure during vehicle operation.



LUBRICANT ADAPTER ALEMITE NO. 6783



ADAPTER DETAILS



DOUBLE CARDAN JOINT

E2707-1F

Front Driveshaft

The front driveshaft connects the power flow from the transfer case to the front drive axle. It incorporates two single cardan universal joint (U-joint) assemblies, a driveshaft with a splined stub shaft end, a boot with two clamps (one large and one small), and a slip yoke which attaches to the transfer case.

NOTE: Whenever the vehicle is raised on a hoist, inspect the rubber boot for rips or tears. Replace if required.

CAUTION: Under no circumstances are aluminum driveshafts to be clamped in the jaws of a vise or similar holding fixture. Denting or localized fracture of the tube may result which could cause driveshaft failure during vehicle operation.

DIAGNOSIS AND TESTING

For additional information refer to Section 15-01, General Driving Axle Service and Section 18-01, Noise, Vibration and Harshness for driveshaft diagnostic and testing procedures.

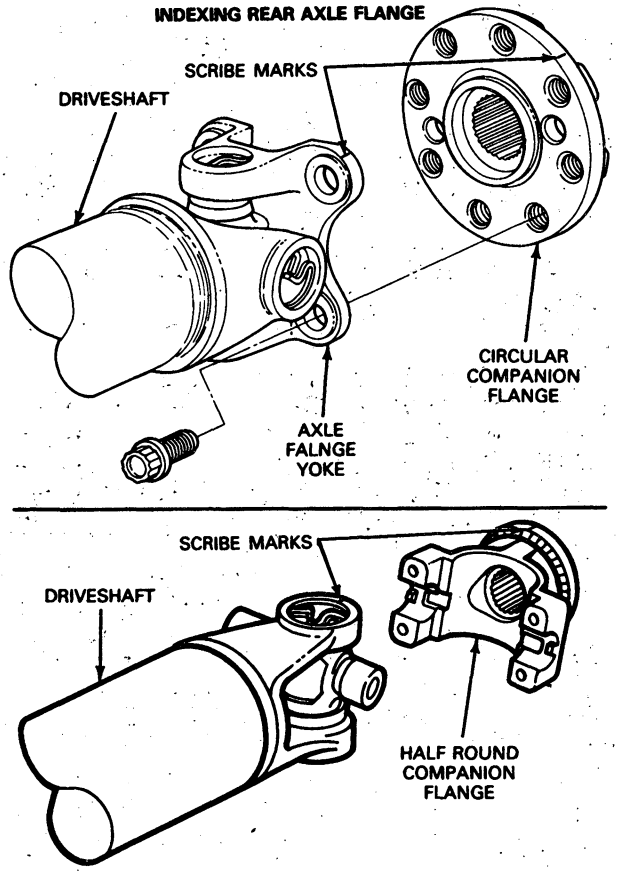
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DIAGNOSIS AND TESTING (Continued)

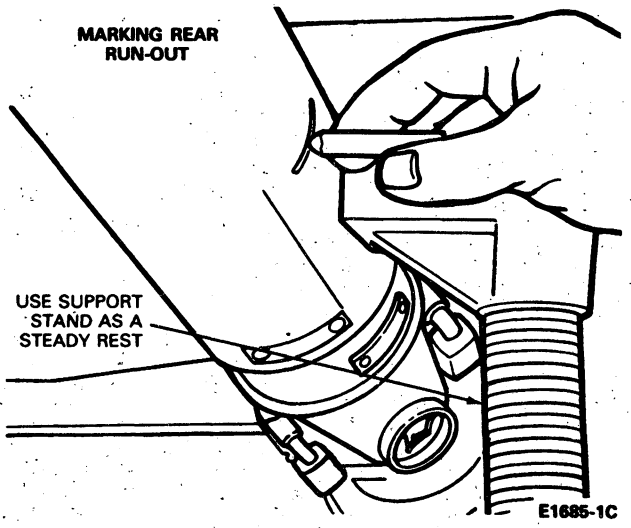
Driveline Vibration

This is a higher-frequency, lower-amplitude vibration than high-speed shake, directly related to road speed, and usually more noticeable at higher road speeds, 72 km/h (45 mph) and up. It is felt in the floor pan or heard as a rumble, hum or boom. It will exist in all drive modes, but may vary somewhat in acceleration, deceleration, float or coast modes. If the vibration is particularly responsive to heavy acceleration or deceleration, especially at lower speeds, driveline angles should be checked. A driveline vibration can usually be duplicated with the axle supported on a hoist or jack stands; through light brake application while accelerating and decelerating, to simulate road load resistance, may be necessary to bring it out.

1. Raise vehicle promptly after road-testing, on twinpost hoist or jack stands, to prevent tire flat-spotting. Engage drive train and run-up to observed road test speed to verify presence of vibration. If not evident, check non-driving wheels with wheel-balancer spinner to rule out imbalance as a possible cause. On 4x4's, unlock front hubs or remove hub covers before spinning wheels. If required, balance non-driving wheels and repeat road test. If vibration is still evident, proceed to driveshaft inspection, Step 3.
2. If vibration appeared in road-speed hoist-test, mark relative position of drive wheels on axle or hub lugs to permit re-installation in original position, and remove wheels. Secure brake drums, if present, by installing all lug nuts in reversed position, and repeat road-speed run-up. If vibration is gone, see drive wheel run-out and balance procedures in this Section. If vibration persists, proceed to Step 3.
3. Inspect driveshaft for signs of physical damage, missing balance weight, undercoating, or improperly seated, worn, or binding universal joints. Check the index marks (paint spots) on rear of shaft and pinion yoke or companion flange. If these marks are more than 90° apart, disconnect shaft and re-index to align marks as close as possible. Clean shaft and repair or replace universal joints as necessary, or replace shaft if damaged. After any corrections are made, re-check vibration at road test speed. If gone, re-install wheels and road test. If vibration persists, proceed to run-out check, Step 4.



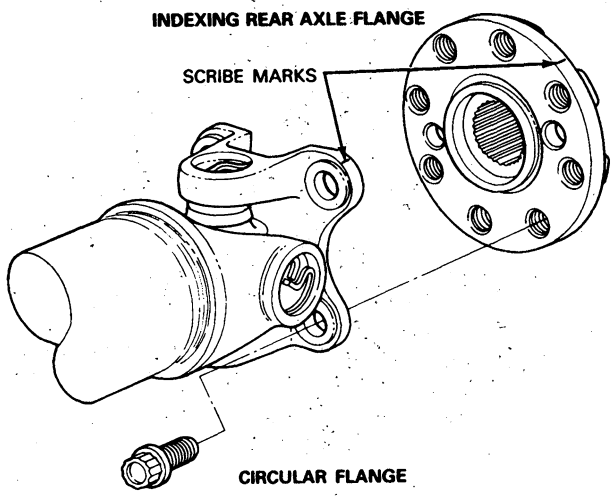
4. With vehicle on hoist and wheels off, measure runout at front, center, and rear of driveshaft with indicator, rotating shaft by turning a brake drum or rotor. On a one-piece shaft, if run-out exceeds .89mm (.035 inch) at front or center, the driveshaft must be replaced. If front and center are within this limit, but rear run-out is not, mark the rear run-out high point and proceed to Step 5. If run-out is within limits at all points, proceed to driveshaft balancing, Step 7.



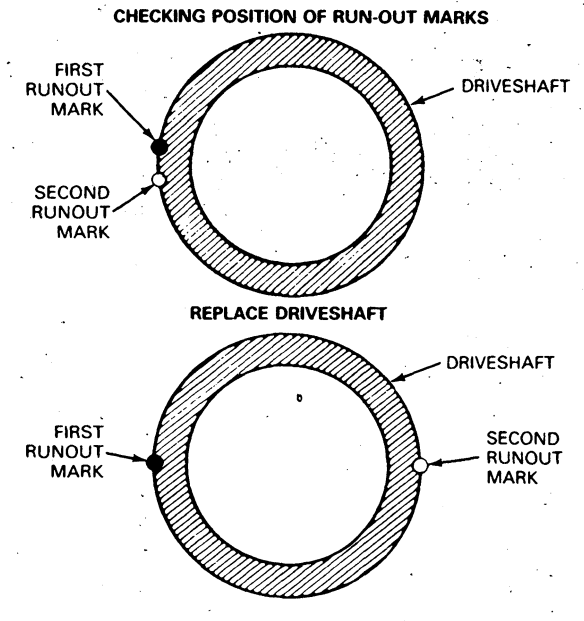
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DIAGNOSIS AND TESTING (Continued)

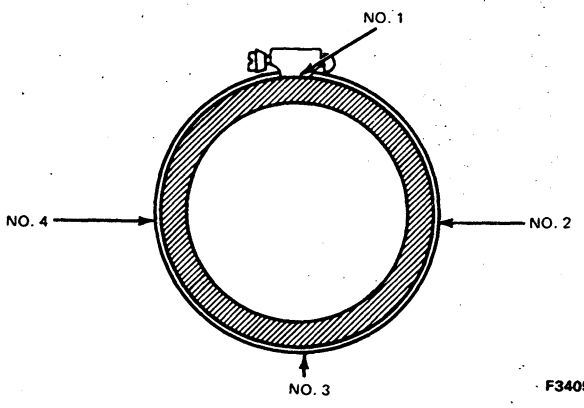
5. Note or mark the indexing of driveshaft to rear axle pinion flange. Disconnect the shaft, re-index 180°, and re-connect. Check run-out at shaft rear, and if still over .89mm (.035 inch), mark high point and see Step 6. If run-out is no longer excessive, check for vibration at road test speed, and, if still present, proceed to Step 7, driveshaft balancing under Adjustments.



6. Excessive driveshaft run-out may originate in the shaft itself or in the companion flange. To determine which, compare the two high points marked in Steps 4 and 5. If the marks are close together, within about 25mm or 1 inch, the shaft is eccentric, and should be replaced and checked for vibration. If the marks are on opposite sides of the shaft, about 180° apart, the yoke or flange is responsible. After replacing check for run-out. When replacing a yoke-type flange, driveshaft runout should not exceed .89mm (.035 inch). When run-out is within limits, recheck for vibration at road speed. If vibration persists, balance the driveshaft.



7. Driveshaft balancing involves installing one or two hose clamps on the driveshaft, near the rear end of a one-piece shaft. Best positioning of the hose clamp head(s) can be determined by trial-and-error, if special balancing equipment is not available. If transducer-and-strobe equipment is available, see Adjustments in this Section for balancing procedure.
8. If the driveshaft was not previously indexed to correct run-out, mark original position of shaft relative to companion flange, index 180°, and roadtest. If after roadtest, the condition is not improved, return the shaft to the original position.
9. Mark off the rear of the driveshaft into four approximately equal sectors, and number the marks 1 through 4. Install a hose clamp on the shaft with its head at position No. 1. Check for vibration at road speed. Re-check with the clamp at each of the other positions, to find the position for minimum vibration. If two adjacent positions show equal improvement, position the clamp head between them.

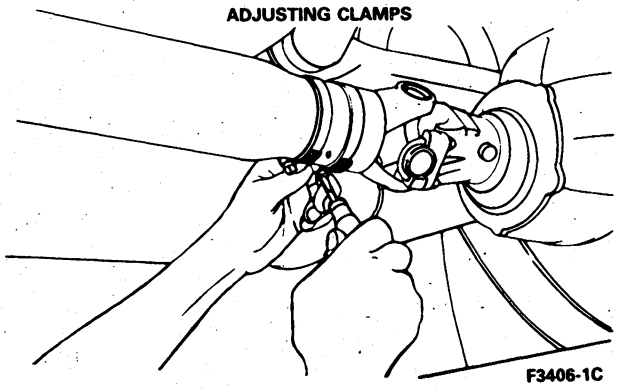


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DIAGNOSIS AND TESTING (Continued)

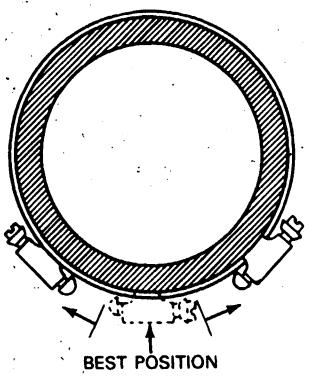
10. If condition is still not acceptable, add a second clamp at the same position and re-check vibration. If no improvement is noted, rotate the clamps in opposite directions, equal distances from the best position determined in Step 9. Initially, separate the clamp heads about 12mm or 1/2 inch, and re-check vibration at road speed.

ADJUSTING CLAMPS



F3406-1C

DETERMINING BEST POSITION FOR CLAMP POSITION



F3407-1B

Repeat the process with increasing separation until the best combination is found, or vibration is reduced to an acceptable level.

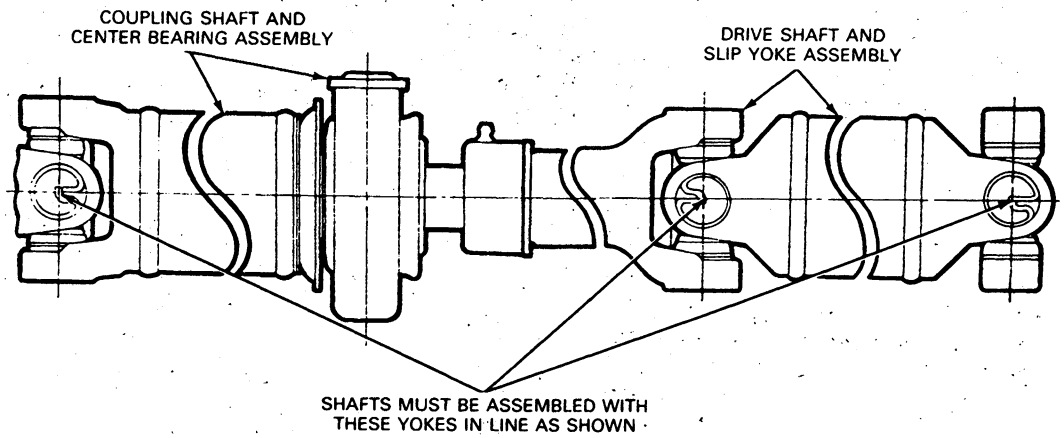
11. Install wheels and road test, since vibration noticeable on the hoist may not be evident during the road test. If vibration is still not acceptable, replace the axle pinion nose damper. If road test is not acceptable, replace axle ring gear and pinion set.

U-Joint Phasing

When U-joint yokes are assembled to their shafts in the same plane, they are in phase. When they are assembled to the shafts in different planes, they are out of phase.

To obtain vibration-free operation, check and correct as necessary.

U-JOINT PHASING-TWO-PIECE DRIVELINE SYSTEM



E3670-2C

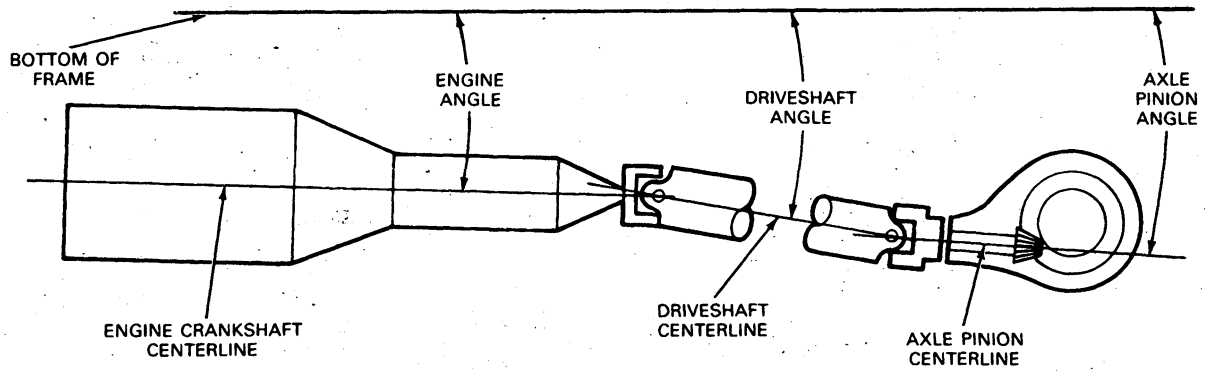
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DIAGNOSIS AND TESTING (Continued)

Driveline Angularity

Driveline angularity is the angular relationship between the engine crankshaft, the driveshaft and the rear axle pinion. Factors determining driveline angularity include ride (spring) height, and engine mounts.

Low speed vibration, less than 72 km/h (45 mph), especially when the vehicle is subjected to heavy acceleration or deceleration is an indication of improper driveline angles. When these conditions exist, check the universal joints for proper seating, mounting and operation.



F4559-2A

Universal Joint Inspection

Prior to checking driveline angularity, inspect the universal joints on the driveshaft for proper operation.

Place the vehicle on a frame hoist and rotate the driveshaft by hand. Check for rough operation or seized U-joints. If the U-joint shows signs of seizure, excessive wear or improper seating, scribe alignment marks on the driveshaft and rear axle companion flange. Remove the driveshaft and remove and replace the U-joint. Install the driveshaft in the marked original position.

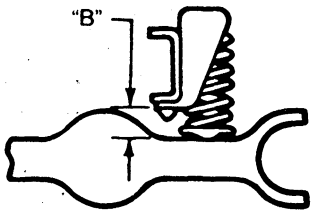
Driveline Angle Check

1. Raise the vehicle on a drive-on type hoist or back onto a front-end alignment rack. Jounce the vehicle to normalize the suspension. This ensures that the suspension components are in the normal-load condition.

NOTE: Driveline angles are given in relation to a 0° longitudinal (fore-aft) unibody frame rail angle and are specified for individual components. Refer to the Specifications portion of this Section for the specified engine, driveshaft and pinion angle.

2. Measure the Ride Height. The vehicle must be in the curb weight (unloaded) condition. Find the recorded ride height in the Driveline Angle chart in the Specifications portion of this Section. The specified driveline angles correspond to the measured ride height.

RIDE HEIGHT MEASUREMENT



BOTTOM OF SPRING TOWER TO TOP OF AXLE MEASURED AT OUTBOARD FRONT FACE OF JOUNCE STOP

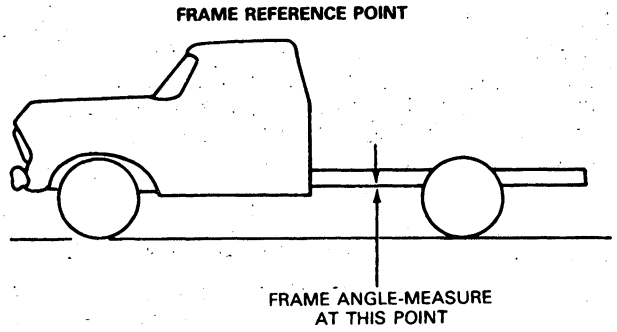
F5027-1A

3. Driveline angles are measured with Pinion Angle Level Gauge, T68P-4602-A or equivalent, as described in Step 4, or with an adjustable bubble (spirit level) protractor as described in Step 5. The protractor is used when the tool kit is not available or when the angles to be measured are more than 12 degrees. All angles should be read within 1/2 degree with the tool or protractor held plumb on a clean, flat surface.

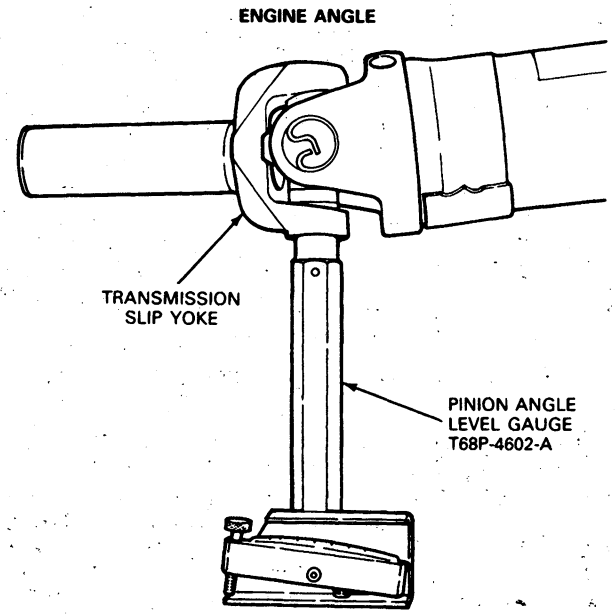
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DIAGNOSIS AND TESTING (Continued)

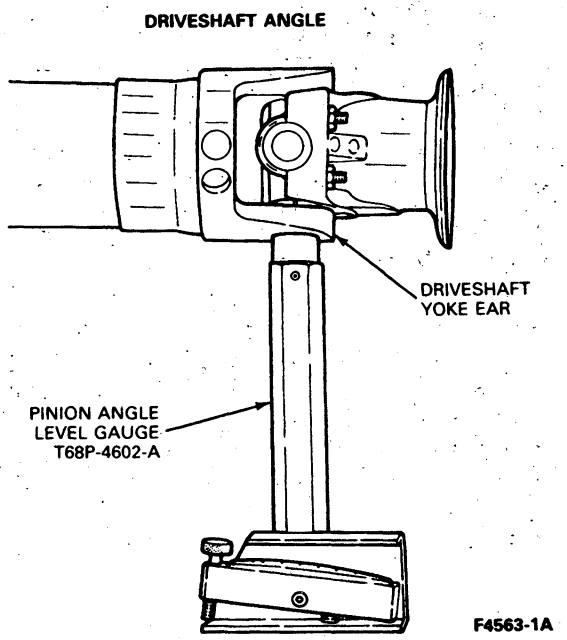
4. **DRIVELINE ANGLE CHECK WITH PINION ANGLE LEVEL GAUGE, T68P-4602-A (or equivalent).** Place the vee magnet of the tool on the bottom of the vehicle frame as shown and calibrate the tool to a 'zero' bubble reading. This gives the 0° frame angle. Take and average the readings from both sides to obtain a more accurate reading.



Check the engine angle by rotating the driveshaft until one transmission slip yoke ear is parallel to the floor. Remove the retaining snap ring from the yoke. Install the Pinion Angle Level Gauge and record the angle reading. If the angle reading differs from the specified angle by 1° or more, proceed to Engine Angle Adjustment and neutralize the engine and transmission mounts. With the Engine Angle at specifications, check the Driveshaft and Pinion Angles. Re-install the snap ring.



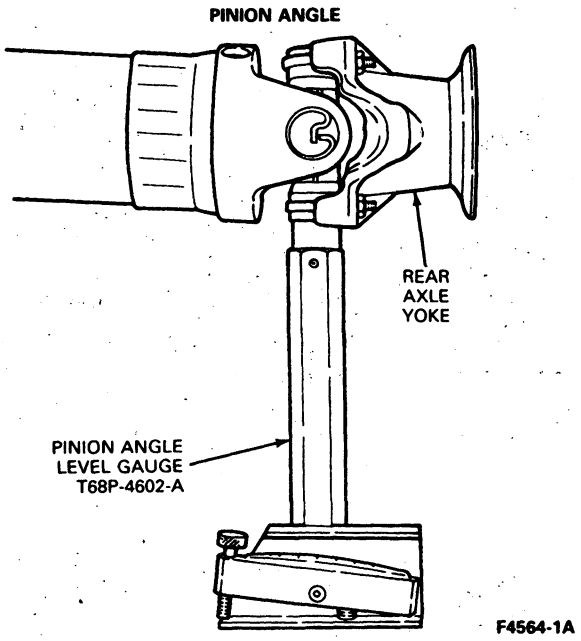
To check the driveshaft angle, rotate the driveshaft so one driveshaft yoke ear is parallel to the floor. Remove the retaining snap ring from the yoke. Install the magnetic Pinion Angle Level Gauge on the U-Joint bearing cup and record the angle reading. Reinstall the snap ring. Check the Pinion Angle and if both or either reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



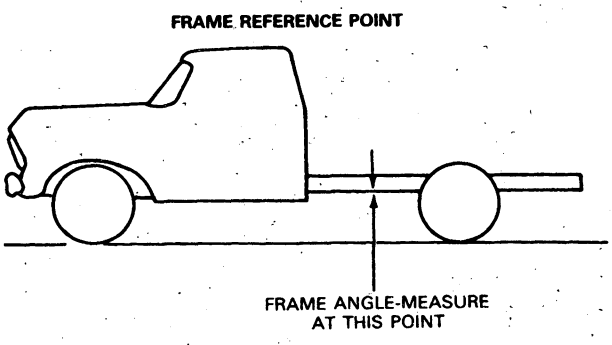
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DIAGNOSIS AND TESTING (Continued)

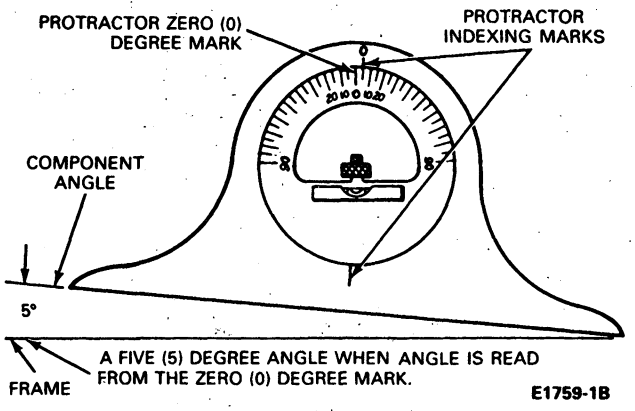
To check the Pinion angle, rotate the driveshaft so that one ear of the rear axle yoke is parallel to the floor. Remove the retaining snap ring from the yoke. Install the Pinion Angle Level Gauge and record the reading. If the reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



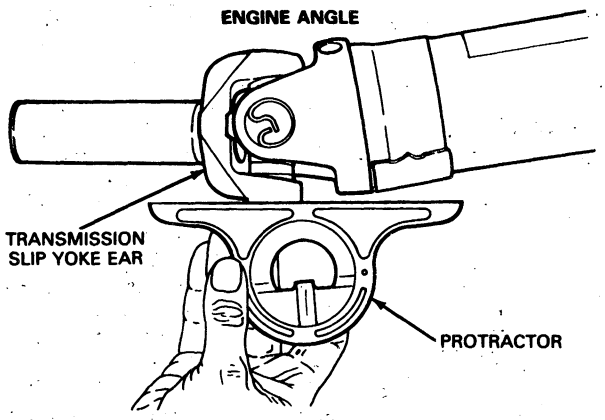
5. DRIVELINE ANGLE CHECK WITH ADJUSTABLE BUBBLE (SPIRIT LEVEL) PROTRACTOR: Place the protractor on the bottom of the vehicle frame directly below the front driver/passenger seat. This gives the 0° frame angle. Take and average the readings from both sides to obtain a more accurate reading. Calibrate the level to a 0° bubble reading.



NOTE: When using a bubble (spirit level) protractor, the angles are read from the 0° frame angle. The 90° mark on the protractor is read as the 0° frame angle. For example, when the protractor is placed on the component and the protractor reads 85°, the component angle is actually 5°.



To check the Engine Angle, rotate the driveshaft until one transmission slip yoke ear is parallel to the floor. Place the protractor so it is flush against the slip yoke ear. Make sure the protractor is not resting against any portion of the driveshaft assembly. Record the angle reading. If the engine angle reading differs from the specified angle by 1° or more, proceed to Engine Angle adjustment and normalize the engine and transmission mounts. Refer to diagnosis and testing following this Section. With the Engine Angle at specifications, check the driveshaft and pinion angles. Refer to angle specifications following this Section.

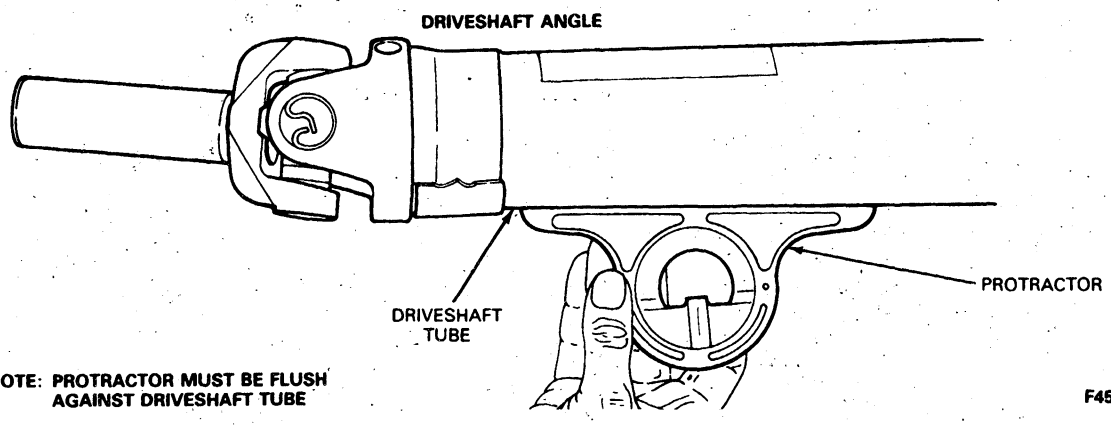


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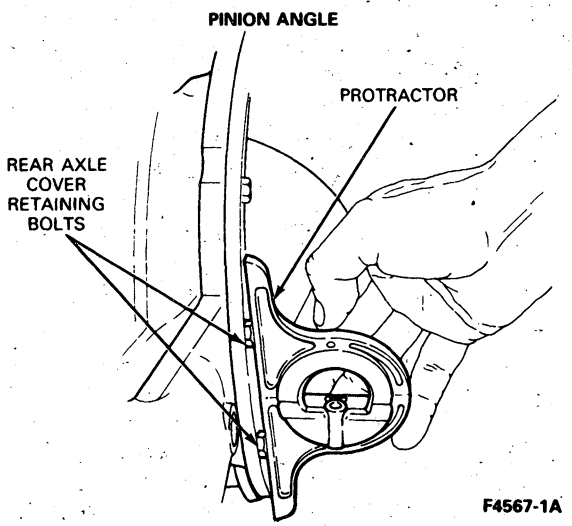
DIAGNOSIS AND TESTING (Continued)

To check the Driveshaft Angle, place the protractor on any portion of the driveshaft tube so the plane surface of the protractor is flush against the bottom surface of the tube and parallel to the floor.

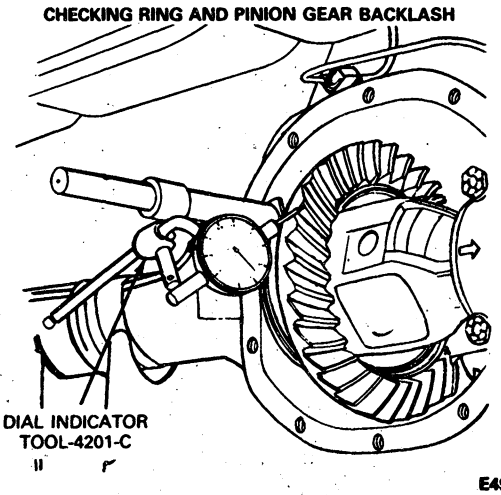
Record the reading. Check the Pinion Angle and if both or either reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



To check the Pinion Angle, place the protractor in a vertical position so it is flush against two rear axle cover retaining bolts. Rotate the protractor bubble indicator so the 90° marks align with the indexing marks. Calibrate the bubble to the 'level' marking and read the protractor. For example, if the protractor indicates a reading of 85°, the Pinion Angle reading is 5°. Record the reading. If the reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



6. Road test to verify resolution of condition. If driveline angle correction and driveline runout/ balance procedures (refer to Driveshaft Balancing—Strobe and Transducer Method in this Section) do not eliminate the vibration condition, the axle ring gear and pinion gearset should be checked for backlash variation. Remove the axle cover plate as described in the appropriate Rear Axle Section. Measure ring gear backlash on thirty consecutive ring gear teeth and note the variation between the high and low readings. If over 0.10mm (0.004 inch) replace the gearset as described in the appropriate Rear Axle Section.



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DIAGNOSIS AND TESTING (Continued)

Driveline Angle Correction

Engine Angle Adjustments

The engine angle is adjusted by normalizing the engine mounts. The engine mounts are normalized by operating the engine until normal operating temperature is obtained. Stop the engine and loosen but DO NOT REMOVE the engine and transmission mount fasteners. Operate the engine at curb idle and place the transmission in Drive or first gear and then stop the engine. Tighten all fasteners to the specified torque. Recheck the engine angle, if the angle is still out of specification, place shims under the transmission to rear crossmember mount until the specified angle is obtained. If the engine transmission angle is still out of specification, place shims under the transmission to rear crossmember mount until the specified angle is obtained.

Coupling Shaft Angle Adjustment

Check coupling shaft angle (if so equipped) and adjust to specification by shimming the center support bearing. Refer to center support Bearing Shimming in the Two Piece Driveshaft Service portion of this Section.

Driveshaft and Pinion Angle Adjustment

Check the driveshaft angle and adjust to specifications by shimming between the rear springs and the spring seats.

Adjust the pinion angle by placing tapered shims between the springs and spring seats. On F-150, a 63-5mm (2 1/2 inch) wide shim (Part No. C3TZ-5A313-A or equivalent) is available for a 2° change. On E-150 and Bronco, a 63.5mm (2 1/2 inch) wide shim (Part No. C3TZ-5A313-E or equivalent) is available for a 3° change. On E-250—E-350, F-250—F-350, and F-Super Duty, a 76.2mm (3 inch) wide shim (Part No. C6TZ-5A313-B or equivalent) is available for a 3° change.

Two-Piece Driveshaft Service

The two-piece driveshaft used in longer wheelbase light truck models introduces some special considerations to diagnosis and testing. As compared with a one-piece installation, the two-piece design includes a front, or "coupling" shaft, a rubber-insulated frame-mounted center bearing, a splined slip joint and an intermediate universal joint at the front of the rear driveshaft.

Center Support Bearing Shimming

Drive-away shudder is the predominant symptom associated with driveline angles condition on F-150—F-250 vehicles with two piece driveshafts. After eliminating coupling shaft phasing condition as the possible cause, drive away shudder can usually be serviced by shimming down the center support bearing in 1/4 inch increments using shims, E0TA-4A209-AA, or equivalent until the drive away shudder is eliminated. Plate stock must be used to maintain proper preload compression of the rubber insulator.

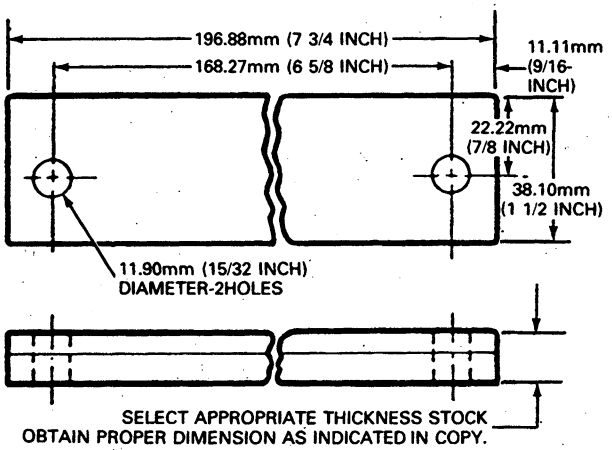
Replace the existing bolts with the appropriate length 7/16-14 hex head bolts.

Tighten bolts to 51-73 N·m (37-54 ft-lb).

Road test to verify resolution of condition.

If the drive away shudder cannot be serviced by shimming down the center support bearing proceed to the driveline angle checking and service procedure in the following paragraphs.

CENTER SUPPORT SHIM DIMENSIONS



MATERIAL: HOT ROLLED LOW CARBON STEEL

Y1978-1C

Coupling Shaft/Center Bearing Alignment

E-150—E-250—E-350 and F-150—F-250—F-350—F-Super Duty Vehicles with Two Piece Driveshaft

Vehicle noise and vibration can be caused by dislocated and/or failed center bearing rubber insulator, contaminated center bearing or excessive compression of the rubber insulator.

The service for this condition is as follows:

1. Remove the coupling shaft assembly from the vehicle.
2. Perform the following steps:
   - A. Remove the support bracket and retainer.
   - B. Remove the rubber insulator.
   - C. Press center bearing assembly and bearing retainer off the coupling shaft.
   - D. Press the dust slinger off the coupling shaft.
3. Replace with center bearing assembly kit D9TZ-4800-A or equivalent in all cases except E4TZ-4800-A for F-250 HD, F-350 and F-Super Duty with M5HD transmission.
4. Reassemble the coupling shaft.

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DIAGNOSIS AND TESTING (Continued)

NOTE: First install bearing in rubber insulator and press bearing on shaft with the turned in lip toward the dust slinger (forward). The support bracket must be installed with the deep flange rearward.

5. Reinstall the driveline in the vehicle with the yokes phased properly.
6. Road test to verify resolution of condition.
7. If vibration still exists, insert 1.19mm (1/16 inch) shims between support bracket and support plate (on bolt ends of support bracket) to reduce compression of the rubber insulator as required.

Slip Yoke Spline

E-150—E-350, F-150—F-350 and F-Super Duty Vehicles With Two Piece Driveshaft

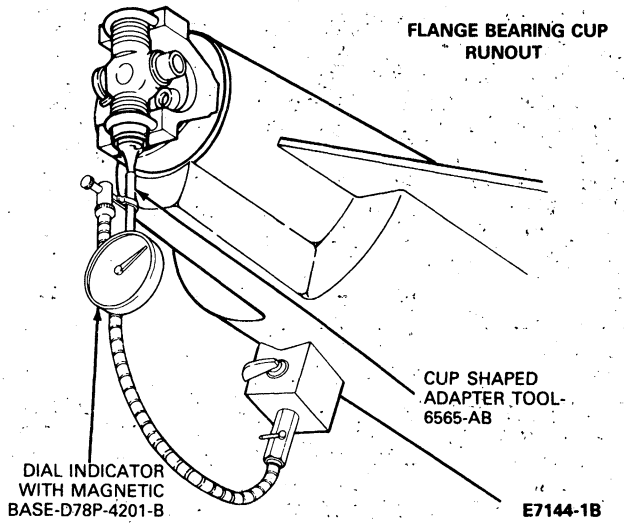
Vehicle noise and vibration can be caused by a seized driveshaft slip yoke spline resulting in the rubber isolator being pulled out of the center bearing support.

The service resolution to minimize slip yoke spline contamination and ultimate seizure is as follows:

1. Disconnect the driveshaft from the rear axle yoke and remove it from the truck.
2. Clean the male splines of the coupling shaft using care not to damage the plastic coating. Fine abrasive cloth may be required to dress and polish the male spline. Remove all hardened grease deposits, dirt, or rust. Inspect for worn or galled splines. The plastic coating on the stub spline must not be removed. Replace coupling shaft if necessary.
3. Clean and inspect the female splines of the slip yoke, removing any hardened grease deposits, dirt or rust. Inspect splines for worn or galled conditions, replace slip yoke if necessary.
4. Apply a coating of Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent to the entire splined stub end of the coupling shaft assembly prior to the assembling of the driveshaft to the coupling shaft.
5. Using a clean long handle (stencil type) brush apply Long Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent spread evenly on all the female splines of the slip yoke. The spline joint must slide freely by hand.
6. Assemble the driveshaft to the coupling shaft with the yokes phased properly. Attach driveshaft to rear axle yoke.
7. Using a hand type grease gun, lubricate the driveshaft slip yoke through the zerk fitting with Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

Rear Axle Companion Flange Runout Check

1. Raise the vehicle on a hoist that supports the rear axles (twin-post hoist).
2. Remove the driveshaft assembly (Section 15-60 Driveshaft—Single Snap Ring Type U-Joint).
3. Check the companion flange for damage to the universal joint bearing locating lugs. If the lugs are shaved (worn) or damaged, replace the flange.
4. The companion flange runout is checked with a dial indicator with 25.40mm (1.000 inch) minimum travel, and a cup-shaped dial indicator adapter TOOL-6565-AB or equivalent. To fabricate the checking tool, modify a universal joint assembly by removing two bearing cups that are opposite each other, and cutting or grinding off one of the universal joint bearing flanges.
5. Install the cup-shaped adapter on the dial indicator stem. Install the dial indicator on the pinion nose. Position the indicator to allow an indication at the ends of the universal joint bearing cups and the remaining exposed journal of the cross-shaft.



6. Turn the companion flange so that the dial indicator cup-type adapter rests on the machined surface of the bearing cup. Rotate the companion flange side-to-side slightly to obtain a reading indicating that the bearing cup surface is perpendicular to the adapter. This will be the point at which the dial indicator cup is closest to the center of companion flange rotation. It is also the point at which the dial indicator hand will reverse direction as the companion flange is turning.

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DIAGNOSIS AND TESTING (Continued)

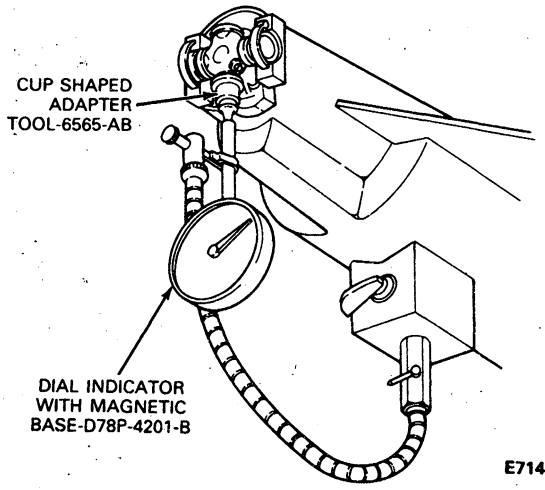
7. Carefully retract the dial indicator stem and rotate the companion flange 180 degrees to position the machined surface of the opposite universal bearing under the dial indicator adapter tool. Again, slightly rotate the flange side-to-side to position the bearing perpendicular to the dial indicator adapter. Again, this is the point at which the indicator hand will reverse direction as the flange is rotated. Record the flange bearing cup runout reading obtained from the indicator.

Rotate the companion flange 90 degrees and position the dial indicator adapter on the machined end of the exposed journal. Be sure the end surface of the journal is perpendicular to the adapter. This requires that the cross-shaft be moved fore and aft on the flange bearing cups. Note the point at which the indicator hand reverses direction.

Rotate the flange assembly side-to-side until the cross-shaft is perpendicular to the pinion shaft axis, and the indicator hand reverses direction. Zero the dial indicator and check the zero point again by slightly moving the cross-shaft fore and aft; then, rotate the companion flange from side-to-side.

8. With the indicator at zero, carefully retract the dial stem and rotate the flange 180 degrees. Rotate the cross-shaft 180 degrees on the flange bearing cups to position the exposed journal under the dial indicator adapter. Rock the cross-shaft fore and aft and the companion flange side-to-side to establish the point at which the indicator hand reverses direction. This will determine the driveshaft universal cross-shaft runout. Record this reading.
9. Repeat Steps 5 through 8 at least three times and average the indicator readings obtained.

CROSS-SHAFT RUNOUT CHECK



E7145-1A

10. To determine the total (combined) companion flange runout, use the combined runout guide. With an indicated 0.003-inch flange bearing cup runout and an indicated 0.004-inch universal cross-shaft runout, the combined companion flange runout will be 0.005-inch.

Flange Bearing Cup Runout	Driveshaft Universal Cross-Shaft Runout — Inch												
	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.000	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.001	0.001	0.0013	0.0022	0.0032	0.0042	0.0051	0.0061	0.0071	0.0081	0.0091	0.0010	0.011	0.012
0.002	0.002	0.0022	0.0027	0.0037	0.0045	0.0053	0.0062	0.0072	0.0082	0.0092	0.0101	0.0111	0.0121
0.003	0.003	0.0032	0.0036	0.0042	0.005	0.0058	0.0067	0.0077	0.0085	0.0094	0.0104	0.0113	0.0123
0.004	0.004	0.0042	0.0045	0.005	0.0057	0.0064	0.0072	0.0081	0.009	0.0097	0.0107	0.0116	0.0126
0.005	0.005	0.0051	0.0053	0.0058	0.0063	0.0071	0.0078	0.0087	0.0094	0.0102	0.0111	0.012	0.013
0.006	0.006	0.0061	0.0062	0.0068	0.0072	0.0078	0.0085	0.0092	0.010	0.0108	0.0116	0.124	0.0134
0.007	0.007	0.0071	0.0073	0.0075	0.0081	0.0087	0.0093	0.0099	0.0103	0.0114	0.0122	0.013	0.0138
0.008	0.008	0.0081	0.0082	0.0087	0.009	0.0094	0.010	0.0104	0.011	0.012	0.0128	0.0135	0.0144
0.009	0.009	0.0091	0.0092	0.0094	0.0097	0.102	0.108	0.0114	0.012	0.0127	0.0134	0.0141	0.015
0.010	0.010	0.010	0.0101	0.0104	0.0107	0.0111	0.0116	0.0122	0.0128	0.0134	0.0141	0.0148	0.0156
0.011	0.011	0.011	0.0111	0.0113	0.0116	0.012	0.0124	0.013	0.0135	0.0141	0.0148	0.0154	0.0162
0.012	0.012	0.012	0.0121	0.0123	0.0126	0.013	0.0134	0.0138	0.0144	0.015	0.0156	0.0162	0.0169

The total (combined) companion flange runout is located in the square where the columns containing the flange bearing cup runout and universal cross shaft runout readings intersect.

CE3683-2A

11. If the reading obtained in Step 10 exceeds specifications, re-position the companion flange 180 degrees on the pinion shaft and repeat Steps 1 through 11.
12. If the repeat readings still exceed specifications, re-position the flange an additional 90 degrees on the pinion shaft and check the runout (Steps 4 through 10).
13. If the runout is still excessive, replace the companion flange and check the runout. If necessary, rotate the new flange on the pinion shaft until an acceptable runout is obtained.

If excessive runout is still evident after replacement of the companion flange, replace the ring gear and pinion and repeat the above checks until the runout is within specifications.

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DIAGNOSIS AND TESTING (Continued)

Diagnosis Guides

The diagnosis guides in this Section can be used when diagnosing driveshaft conditions.

DRIVELINE COMPLAINTS

CONDITION	POSSIBLE CAUSE	RESOLUTION
Driveline Concerns	1. Rear spring U-bolt loose.	1. Retighten U-bolts and driveshaft.
	2. U-joint worn or improperly installed.	2. Install or replace U-joint.
	3. Coupling shaft center support bearing improperly installed.	3. Correctly install bearing and replace if damaged.
	4. Excessive runout or damaged U-joint.	4. Rotate flange 180 degrees and install. Recheck, and if not acceptable, replace flanges and/or U-joint and repair as required.
	5. Excessive lateral and radial tire and wheel runout.	5. Refer to Section 11-01, General Wheel and Tire Service.
	6. Excessive driveshaft runout.	6. Replace driveshaft or rotate driveshaft 180 degrees and check for out-of-balance condition.
	7. Driveshaft out-of-balance.	7. Rebalance driveshaft.
	8. Driveline and pinion angles out-of-specification.	8. Adjust to specifications.
	9. Binding, damaged or galled splines on slip yoke.	9. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B).
Noise on Drive or Coast	1. Improper driveline angles or phasing.	1. Adjust or correct as required.
Loud clunk in the Driveline when shifting from reverse to forward.	1. Loose or worn driveshaft components, companion flange attaching nut below specifications.	1. Inspect, repair, replace as required.

CE4771-2G

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DIAGNOSIS AND TESTING (Continued)

DRIVESHAFT VIBRATES

TEST STEP		RESULT	ACTION TO TAKE
1.0	VERIFY CONDITION		
	The following procedure should be used to isolate part or parts causing concern when a vibration condition exists which is thought to be caused by driveline components. • Road test vehicle to determine critical vibration points. Note road speed, engine RPM, and shift lever positions at which vibration occurs. • Stop vehicle and run engine with clutch depressed through critical speed ranges noted above.	OK ▶ OK ▶	If excessive vibration is present, correct engine or clutch condition causing vibration. GO to **2.**
2.0	TRANSMISSION CHECK		
	• With transmission in neutral and clutch engaged, run engine through critical speed ranges and note if any excessive vibration is apparent.	OK ▶ OK ▶	STOP. GO to **3.**
3.0	TRANSMISSION ALIGNMENT		
	• Check transmission to clutch housing alignment.	OK ▶	Align transmission and clutch housing.

CE4769-2B

ADJUSTMENTS

Driveshaft Balancing

Vibration or shudder which is noticeable either on fast acceleration, when coasting, or when using the engine for braking, may be caused by the rear axle housing being loose on the rear suspension, improper tire balance, improper driveline installation, or driveline balance.

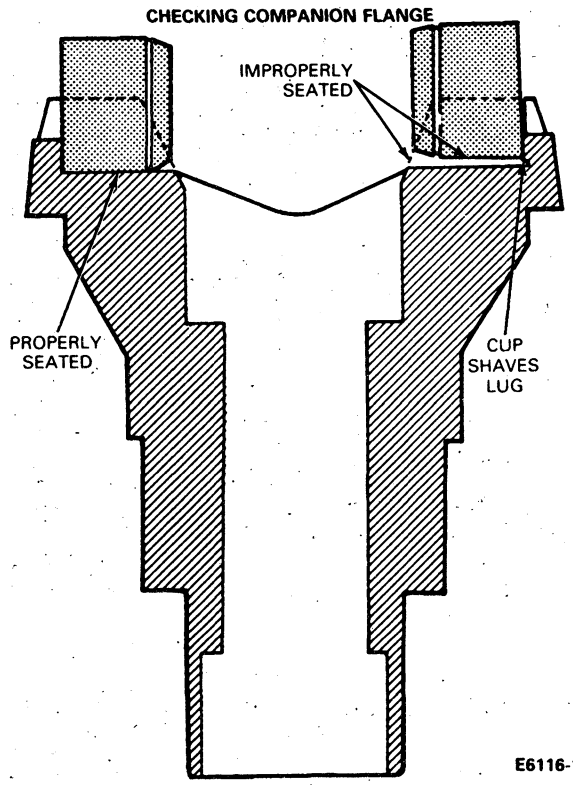
If driveshaft components are replaced and shaft vibration is encountered after installation, disconnect the shaft and remove the slip yoke. Rotate the slip yoke 180 degrees; then, reconnect the shaft to the slip yoke and reinstall in vehicle. If the vibration persists, disconnect the shaft at the rear axle companion flange. Rotate the companion flange 180 degrees and reconnect the shaft to the flange.

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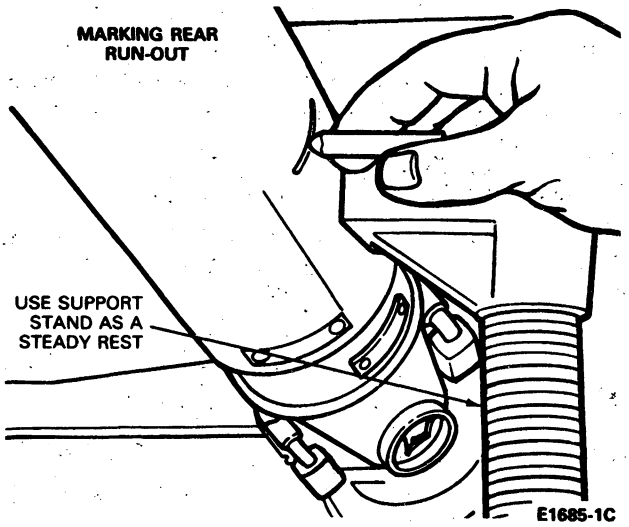
ADJUSTMENTS (Continued)

If rotating the driveshaft 180 degrees does not eliminate vibration, the driveshaft may be balanced, using the following procedure:

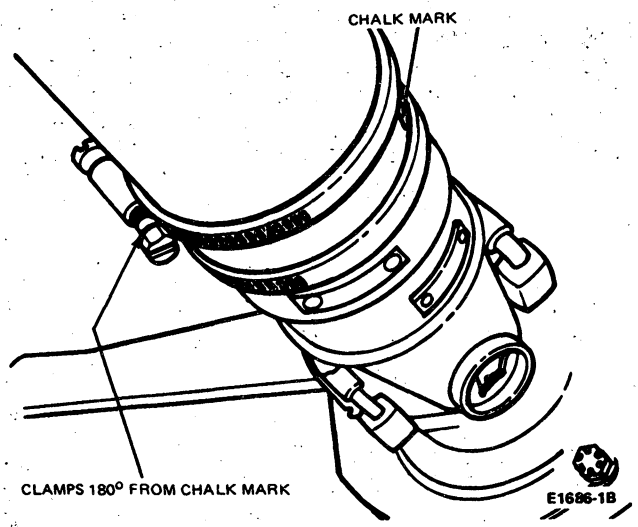
1. Raise the vehicle on a twin-post hoist so that both the front and rear axles are safely supported with all wheels free to rotate.
2. Remove the rear wheels and tires. Reinstall lug nuts to retain brake drums or rotors.
3. With the transmission in gear, increase the vehicle speed to the maximum vibration level. Note and record the speed of this vibration period as a baseline speed.
4. Check the attachment of all U-joint bearing caps of the driveshaft to the transmission yoke for improper installation or damaged U-joint bearing cap locating lugs. All yokes with worn, shaved, or damaged locating lugs must be replaced.



5. With the transmission in gear, run the vehicle with the driveshaft rotating at a speedometer speed of 64-80 km (40-50 miles); have an assistant carefully bring a crayon, piece of chalk, or colored pencil up until it just barely contacts the rear end, center and front end of the driveshaft. The chalk marks will indicate the heavy side of the driveshaft. Use caution when checking the driveshaft near the balance weights to prevent injury to the hands.



6. Install two screw-type hose clamps on the driveshaft so that their heads are located 180 degrees from the chalk mark, starting at the pinion yoke end of the driveshaft. Tighten the clamps.



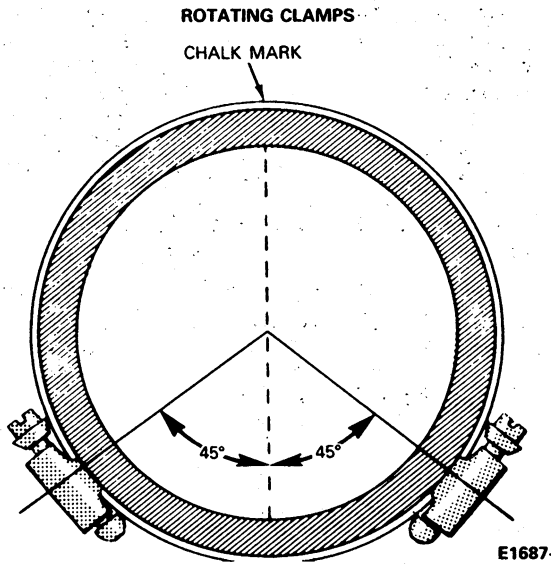
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ADJUSTMENTS (Continued)

7. Run the vehicle up to the baseline speed. If vibration is still evidenced, rotate the clamps approximately 45 degrees away from each other and test for correction of vibration.

CAUTION: To prevent overheating, do not run the vehicle on the hoist for an extended period.

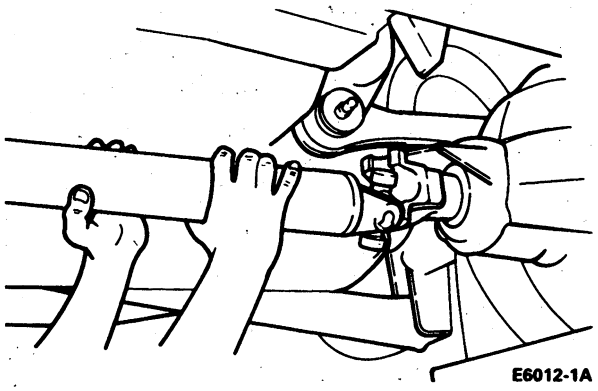
8. If necessary, continue to rotate the clamps apart in smaller increments until the vibration is eliminated or begins to be reduced.
9. If the vibration is not completely eliminated, repeat the foregoing procedure and balance the front end of the driveshaft, checking for elimination or reduction in the vibration level.
10. Reinstall wheels and tires.
11. Remove the vehicle from the hoist and road test.



Alternate In Vehicle Driveshaft Balancing Procedure

Rotunda Dynamic Wheel Balancer (Model 006-01400) or Equivalent Equipment

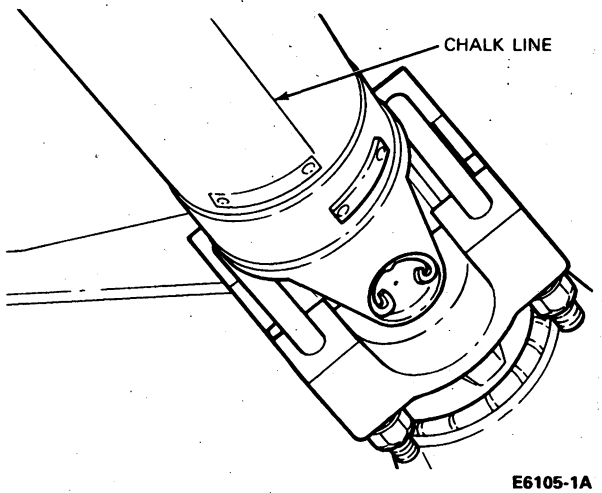
1. Road Test—Evaluate and record road speed at which vibration occurs.
2. Raise vehicle on a frame contact hoist. Remove the wheels and tires. Reinstall lug nuts to retain brake drums. Re-evaluate by starting the engine, engaging the transmission and accelerating to the indicated speeds at which the vibration was most severe during the road test. Suspending the rear axle makes the driveline more sensitive to vibration.
3. Disconnect the driveshaft from the companion flange. Rotate the driveshaft 180 degrees from its original position and re-install. Repeat evaluation per Step 2 above.



NOTE: In some cases, rotating the driveshaft 180 degrees may decrease the vibration to an acceptable level. However, if the vibration level is increased, install the driveshaft in its original position and proceed to Step 4.

4. A vehicle is more sensitive to excessive imbalance and/or runout at the rearward end of the driveshaft; therefore, locate the heavy side of the driveshaft by the use of the strobe light and transducer, as follows:

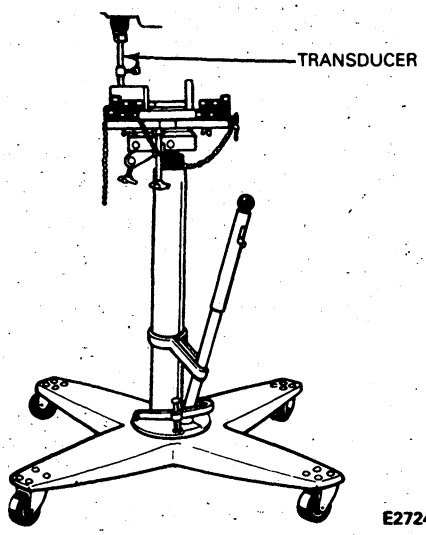
Scribe an axial chalk line (at any radial location) approximately 4 inches long at the rear of the driveshaft. Locate the transducer on the bottom side of the carrier, and secure it in place. Run the engine and driveline at the worst vibration speed noted and visually note the position of the chalk line by use of the strobe light. This provides a starting point for the initial location of the clamps.



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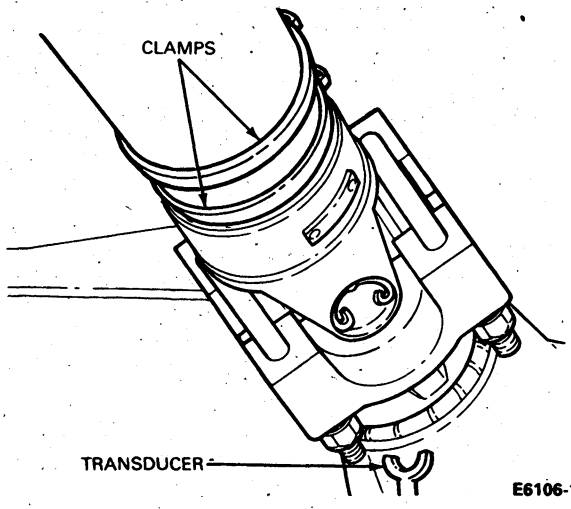
ADJUSTMENTS (Continued)

LOCATING TRANSDUCER



E2724-1B

5. Stop the engine and rotate the driveshaft so that the chalk line is in the same location as it was noted under the strobe light.
6. Install two (stainless steel) hose clamps on the driveshaft. Position the clamp heads 180 degrees from the transducer and tighten the clamps.



E6106-1A

7. Run the engine and driveline through the speed range. If no vibration is felt, remove the lug nuts, install the wheels and tires and reinstall the lug nuts in the correct position and proceed to Step 9. However, if any vibration still exists, the combined weight of the two hose clamp heads may be in excess. To reduce this excess weight, rotate the clamp heads away from each other approximately 15 degrees (one each way from the original position). Run the engine and driveline and note if the vibration has been reduced.

CAUTION: Do not run the engine with the transmission engaged on the hoist for extended periods due to the danger of overheating the engine and/or transmission.

8. Continue to rotate the clamp heads apart in smaller angular increments until the vehicle feel of balance (vibration) is best. At this point, install the wheels and tires per Step 7 above and road test the vehicle to determine the actual degree of improvement. If satisfactory improvement has been obtained, proceed with Step 9. If no improvement has been obtained, the clamps must be removed and diagnosis should be re-directed to other areas, such as wheels, tires, driveline angle, and companion flange runout. For additional information refer to Diagnosis and Testing in this Section.
9. When the vehicle has been corrected to a satisfactory level, as determined by a road test evaluation, tighten the clamps securely. Clean thoroughly with lacquer thinner, and spray the clamps with a commercially available black paint for a finished appearance.

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SPECIFICATIONS

ENGINE ANGLE TO HORIZONTAL — BRONCO

Model	Wheelbase	Engine	Transfer Case	Engine Angle
Bronco	104"	All Engines	Part Time	5-1/2°

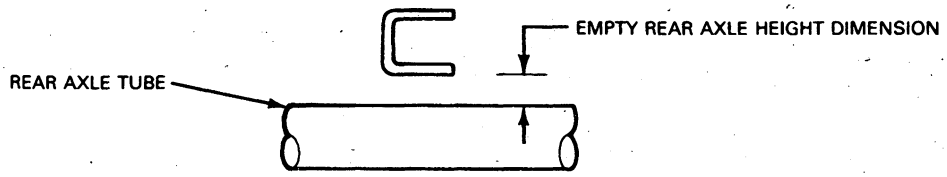
FRONT DRIVESHAFT ANGLE TO HORIZONTAL — BRONCO

Model	Wheelbase	Engine	Transmission	Transfer Case	Curb Load Empty
Bronco	104"	All Engines	All	Part Time	1/4°

REAR DRIVESHAFT ANGLE TO HORIZONTAL — BRONCO

Model	Wheelbase	Engine	Axle	Transmission	Spring Rating at Pad (Lbs)	Transfer Case	Curb Load Empty	Empty Rear Ride Height Axle to Frame ①	
								Inch	mm
Bronco	104	4.9L	3.55	C6	1650	Part Time	11°	6.31	160
	104	5.0L/5.8L	3.50	M4/C6	1650	Part Time	12-1/4°	6.31	160
	104	5.0L	3.55	AOD	1650	Part Time	11-1/4°	6.31	160
	104	5.0L	4.11	AOD	1650	Part Time	12-1/2°	6.31	160

① Measure the emply rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.



REAR AXLE PINION ANGLE TO HORIZONTAL — BRONCO

Model	Spring Capacity at Pad	Spring Part No. 5560	Curb Load Empty
Bronco	1650#	E3TA-ANA	10-3/4°

FRONT AXLE PINION ANGLE TO HORIZONTAL — BRONCO

Model	Transfer Case	Front Axle Pinion Angle
Bronco	Part Time	2-3/4°

CE3675-2G

COUPLING SHAFT ANGLES TO HORIZONTAL AT CURB LOAD EMPTY — E-150, E-250, E-350

Model	Wheelbase		Engine	Axle Ratio	Transmission	Angle
	mm	Inch				
E-150	3505	138	4.9L	3.50	M3	5-3/4°
					M40D	
					C6	
			4.9L	3.55	AOD	
E-250 U/8500	3505	138	4.9L	3.73	AOD	5-3/4°
			5.0L	3.73		
E-350	4013	158	4.9L	4.10	C6	3-1/2°
			5.8L	3.54/4.10		
			6.9L	3.54/4.10		
			7.5L	3.07/3.54/4.10		
E-350	4470	176	6.9L	3.54/4.10	C6	3-1/2°
			7.5L			

CE5836-2B

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SPECIFICATIONS (Continued)

REAR AXLE PINION ANGLES TO HORIZONTAL — E-150, E-250, E-350

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5560)	Curb Load Empty			
	mm	Inch	Lbs.	(Kg)		Ratio	Angle	Ratio	Angle
E-150	3150	124	1250	566	E1TA-ACA	3.55	5°	3.00/3.50	3°
			1450	658	E1TA-ADA	3.55	5°	3.00/3.50	3°
			1685	764	D9TA-AVA	3.55	5°	3.00/3.50	3°
			1750	794	E1TA-AGA	3.55	5-1/4°	3.00/3.50	3°
E-150	3505	138	1250	566	E1TA-AEA	3.55	6-1/2°	3.00/3.50	4-1/4°
			1450	658	E1TA-AFA	3.55	6-1/2°	3.00/3.50	4-1/2°
			1685	764	D9TA-AYA	3.55	7°	3.00/3.50	5°
			1750	794	E1TA-AHA	3.55	6-1/2°	3.00/3.50	4-1/2°
E-250	3505	138	1825	828	D9TA-HA			3.54/3.73	5°
			2100	952	D9TA-JA			3.54/3.73	5°
			2365	1072	E4UA-RA			3.07/3.54/4.10	4°
			2450	1111	D9TA-KA			3.54/3.73	5°
			2700	1224	D9TA-MA			3.07/3.54/4.10	5°
E-350	3505	138	2850	1292	E0TA-BVA			3.07/3.54/4.10	4-1/2
			2950	1338	D9TA-LA			3.07/3.54/4.10	4-3/4°
			3300	1496	E1TA-ALA			3.07/3.54/4.10	5°
E-350	4013	158	3300	1496	E1TA-ALA			3.07/3.54/4.10	5°
E-350	4470	176	3300	1496	E1TA-ALA			3.54/4.10	5°

CE6462-2A

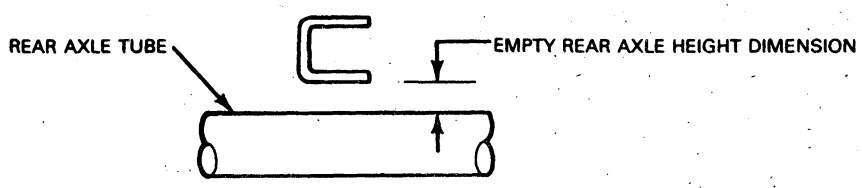
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SPECIFICATIONS (Continued)

DRIVESHAFT ANGLES TO HORIZONTAL AT CURB LOAD EMPTY — E150, E250, E350

Model	Wheelbase		Engine	Rear Axle	Transmission	Spring Rating at Pad (Lbs)	Curb Load Empty Angle	Empty Rear Ride Height (Axle to Frame) ①	
	mm	Inch						Inch	mm
E-150	3150	124	4.9L 5.8L	3.00 3.50	M3 M40D C6	1250	6°	5.08	129
						1450	6-1/2°	5.60	142
						1685	6-1/2°	6.72	171
						1750	7°	5.74	146
E-150	3150	124	4.9L 5.0L	3.55	AOD	1250	4-3/4°	5.08	129
						1450	5-1/4°	5.60	142
						1685	5-1/2°	6.72	171
						1750	5-3/4°	5.74	146
E-150	3505	138	4.9L 5.8L	3.00 3.50	M3 M40D C6	1250	4-1/2°	5.08	129
						1450	4-3/4°	5.60	142
						1685	5-1/4°	6.72	171
						1750	5°	5.74	146
E-150	3505	138	4.9L 5.8L	3.50	M3 M40D C6	1250	4° ②	5.08	129
						1450	4-1/4° ②	5.60	142
						1685	5° ②	6.72	171
						1750	4-3/4° ②	5.74	146
E-150	3505	138	5.0L	3.55	AOD	1250	3-1/2°	5.08	129
						1450	3-3/4°	5.60	142
						1685	4-1/4°	6.72	171
						1750	4°	5.74	146
E-150	3505	138	4.9L	3.55	AOD	1250	2-1/2° ②	5.08	129
						1450	2-3/4° ②	5.60	142
						1685	3-1/2° ②	6.72	171
						1750	3-1/4° ②	5.74	146
E-250	3505	138	4.9L 5.8L	3.54 4.10	AOD C6	1825	6°	7.52	191
						2100	6-1/4°	8.22	209
						2365	5-1/2°	7.20	183
						2450	6°	8.12	206
						2700	6-1/4°		
E-250	3505	138	4.9L 5.0L	3.73	AOD	1825	6° ②	7.52	191
						2100	6-1/2° ②	8.22	209
						2365	5-1/4° ②	7.20	183
						2450	6° ②	8.12	206
						2700	6-1/4° ②		
E-350	3505	138	All	All	C6	2850	6°	9.54	242
						2950	7-1/2°	8.12	206
						3300	6-1/2°	7.50	190
E-350	4013	158	All	All	C6	3300	6-1/4° ②	7.50	190
E-350	4470	176	All	All	C6	3300	4-1/2° ②	7.50	190

① Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration below.
② Two-piece drivelines.



CE6461-2A

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SPECIFICATIONS (Continued)

ENGINE ANGLE TO HORIZONTAL
E-150 — E-250 — E-350

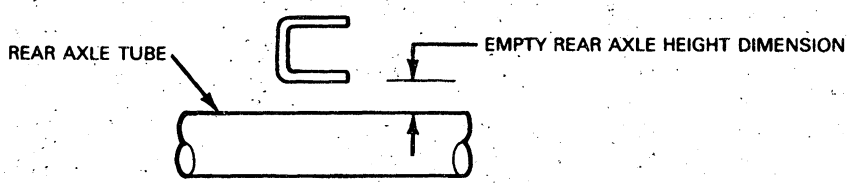
Model	Wheelbase	Engine	Transmission	Angle
All	All	All	All	4°

CE3923-2B

REAR DRIVESHAFT ANGLES TO HORIZONTAL — F-150, F-250, F-350 (4x4) AND BRONCO

Model	Wheelbase		Engine	Rear Axle	Transmission	Spring Rating at Pad (Lbs.)	Curb Load Empty	Empty Rear Ride Height Axle to Frame ①	
	mm	Inch						Inch	mm
F-150 (4x4)	2967	117	4.9L	3.08/3.55	C6/M4/TOD	1654	13°	10.80	274
	2967	117	5.0L	3.50	M4/TOD	1654	14°	10.80	274
	2967	117	5.8L	3.50	C6	1654	14°	10.80	274
	2967	117	5.0L	3.55	AOD	1654	13-1/4°	10.80	274
	2967	117	5.0L	4.11	AOD	1654	14-1/4°	10.80	274
F-150 (4x4)	3378	133	4.9L	3.08/3.55	C6/MA/TOD	1654	9-1/4°	10.80	274
	3378	133	5.0L	3.50	M4/TOD	1654	9-3/4°	10.80	274
	3378	133	5.8L	3.50	C6	1654	9-3/4°	10.80	274
	3378	133	5.0L	3.55	AOD	1654	9-1/4°	10.80	274
	3378	133	5.0L	4.11	AOD	1654	10°	10.80	274
F-250 (4x4) LD	3378	133	All	3.55/4.10	All	1700	9-3/4°	10.62	270
	3378	133	5.0L	4.10	AOD	1700	9-3/4°	10.62	270
F-250 (4x4) HD	3378	133	All	All	All	2590	10°	11.12	282
						2811	10°	10.94	278
F-350 (4x4) SRW	3378	133	All	All	All	2811	12°	10.94	278
F-350 (4x4) DRW	3475	137	All	All	All	3225	11-1/4°		
F-150 (4x4)	3937	155	4.9L	3.08/3.55	C6/M4/TOD	1654	8-1/4°	10.80	274
	3937	155	5.0L/5.8L	3.50	C6/M4/TOD	1654	9-1/4°	10.80	274
	3937	155	5.0L	3.55	AOD	1654	8-1/4°	10.80	274
	3937	155	5.0L	4.11	AOD	1654	9-1/4°	10.80	274
F-250 (4x4) HD	3937	155	All	All	C6	2590	10-1/4°	11.12	282
						2811	10°	10.94	278
	3937	155	All	All	M4T19	2590	10-1/4°	11.12	282
						2811	10°	10.94	278
Bronco	2660	104	4.9L	3.08/3.55	All	1650	11°	6.31	160
	2660	104	5.0L/5.8L	3.50	M4/C6	1650	12-1/4°	6.31	160
	2660	104	5.0L	3.55	AOD	1650	11-1/4°	6.31	160
	2660	104	5.0L	4.11	AOD	1650	12-1/4°	6.31	160

① Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.



CE5835-2B

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SPECIFICATIONS (Continued)

REAR AXLE PINION ANGLES TO HORIZONTAL — F-150, 250, 350 4x4, BRONCO

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5560)	Curb Load Empty			
	mm	Inch	Lbs.	(Kg)		Ratio	Angle	Ratio	Angle
F-150 (4x4)	2967	117	1654	750	E3TA-KA	3.08/3.55	5°	3.50/4.11	5-1/2°
F-150 (4x4)	3378	133	1654	750	E3TA-KA	3.08/3.55	5°	3.50/4.11	5-1/2°
F-150 (4x4)	3937	155	1654	750	E3TA-KA	3.08/3.55	5°	3.50/4.11	5-1/2°
F-250 LD (4x4)	3378	133	1700	771	E4TA-EA	3.55/4.10	7-1/4°		
F-250 HD (4x4)	3378	133	2590	1175	E3TA-AJA	3.55/4.10	6-1/4°		
			2811	1275	E4TA-SA	3.55/4.10	6°		
F-250 HD (4x4)	3937	155	2590	1175	E3TA-AJA	3.55/4.10	6-1/4°		
			2811	1275	E4TA-SA	3.55/4.10	6°		
F-350 (4x4) SRW	3378	133	2811	1275	E4TA-SA	3.55/4.10	6°		
F-350 (4x4) DRW	3475	137	3225	1462	E5TA-YA	4.10	4-1/2°		
BRONCO	2660	104	1650	748	E3TA-ANA	3.08/3.55	10°	3.50/4.11	10-3/4°

CE6460-2A

DRIVESHAFT ANGLE TO HORIZONTAL — F-350 (4x2) (CURB LOAD EMPTY)

Model	Wheelbase		Driveline	Spring Rating at Pad (Lbs)	Transmission						Empty Rear Ride Height Axle to Frame ①	
	mm	Inch			AOD	C6	M3	TOD	M4	T19	Inch	mm
F-350	3378	133	One Piece	2811	—	7-3$°	—	—	—	—	8.54	216
F-350	3378	133	Two Piece	2811	—	9-3/4°	—	—	—	9-1/2°	8.54	216
F-350	3475	137	One Piece	3225	—	7-1/4°	—	—	—	—	8.58	217
F-350	3475	137	Two Piece	3225	—		—	—	8-1/2°		8.58	217
F-350	4084	161	Two Piece	3225	—	6-1/2°	—	—	6-1/2°	6-1/2°	8.58	217

① Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.

CE5832-2B

COUPLING SHAFT ANGLE TO HORIZONTAL — F-150, F-250, F-350 (4x2)

Model	Wheelbase		Wheelbase						
	mm	Inch	AOD	C5	C6	M3	TOD	M4	MA-T19
F-150	3378	133	5°	5°	—	5°	5°	5°	—
F-150	3526	139	4-1/2°	—	4-1/2°	—	4-1/2°	—	—
F-150	3937	155	4°	—	3-3/4°	—	4°	—	—
F-250	3378	133	5°	—	5-1/4°	—	—	5-1/4°	5-1/4°
F-250	3937	155	—	—	4-1/2°	—	—	4-3/4°	4-3/4°
F-350	3378	133	—	—	5°	—	—	—	5-1/4°
F-350	3475	137	—	—	5-1/4°	—	—	5-1/4°	5-1/4°
F-350	4084	161	—	—	4°	—	—	4-1/2°	4-1/2°

CE5830-2B

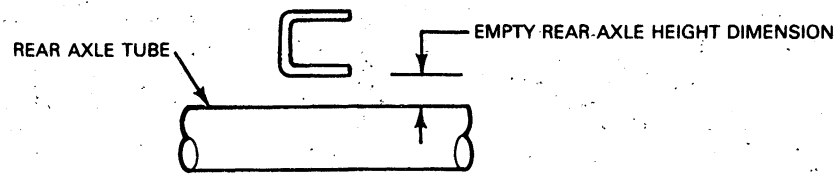
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SPECIFICATIONS (Continued)

DRIVESHAFT ANGLE TO HORIZONTAL — F-150, F-250, F-350 (4x2) (CURB LOAD EMPTY)

Model	Wheelbase		Driveline	Spring Rating at Pad (Lbs)	Transmission							Empty Rear Ride Height Axle to Frame①	
	mm	Inch			AOD	C5	C6	M3	TOD	M4	T19	Inch	mm
F-150	2967	117	One Piece	1235	7-1/4°	7-1/4°	7-1/4°	7-1/4°	7-1/4°	7-1/4°	—	8.87	225
				1375	8°	8°	8-1/4°	8°	8-1/4°	8°	—	8.26	210
F-150	3378	133	One Piece	1235	5-1/2°	5-1/2°	5-1/2°	5-1/2°	5-1/2°	6°	—	8.87	225
				1660	6-1/2°	6-1/2°	6-1/2°	6-1/2°	6-1/2°	7°	—	8.80	223
F-150	3378	133	Two Piece	1235	6°	—	—	6°	6-3/4°	6°	—	8.87	225
				1660	7-3/4°	—	—	7-3/4°	8-3/4°	7-3/4°	—	8.80	223
F-150	3526	139	Two Piece	1660	7-1/2°	—	7-1/2°	—	7-1/2°	—	—	8.80	223
F-150	3937	155	Two Piece	1660	6-1/2°	—	6-1/2°	—	6-1/2°	—	—	8.80	223
F-250 LD	3378	133	One Piece	1700	7°	—	7°	—	—	7°	—	8.58	218
				2450	7-3/4°	—	7-3/4°	—	—	7-3/4°	—	9.44	240
F-250 LD	3378	133	Two Piece	1700		—	8-3/4°	—	—	—	—	8.58	218
				2450		—	10°	—	—	—	—	9.44	240
F-250 HD	3378	133	One Piece	2590	—	—	7-3/4°	—	—	—	—	9.17	233
				2811	—	—	7-3/4°	—	—	—	—	8.54	217
F-250 HD	3378	133	Two Piece	2590	—	—	9-3/4°	—	—	9-3/4°	9-3/4°	9.17	233
				2811	—	—	9-1/2°	—	—	9-1/2°	9-1/2°	8.54	217
F-250 HD	3937	155	Two Piece	2590	—	—	7-1/2°	—	—	7-1/2°	7-1/2°	9.17	233
				2811	—	—	7-1/2°	—	—	7-1/2°	7-1/2°	8.54	217

①Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.



CE5831-2B

FRONT DRIVESHAFT ANGLES TO HORIZONTAL
F-150, F-250 LD, BRONCO (4x4) DANA 44 IFS AND 44 IFSHD AXLE

Model	Wheelbase		Engine	Transmission	Curb Load Empty
	MM	Inch			
F-150 (4x4) Bronco	2660 2967 3378 3937	104 117 133 155	All	All	1/4°
F-250 (4x4) LD	3378	133	All	All	2-3/4°

CE3920-2D

COUPLING SHAFT ANGLE TO HORIZONTAL AT CURB LOAD EMPTY — F-150, F-250 (4x4)

Model	Wheelbase		Engine	Axle Ratio	Trans.	Angle
	mm	Inch				
F-150 (4x4)	3937	155	ALL	ALL	C6, M4, TOD	5°
			ALL	ALL	AOD	5°
F-250 (4x4)	3937	155	5.8L/6.9L/7.5L	ALL	C6, M4	5°
			6.9L/7.5L	ALL	T19	5°

CE6458-2A

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SPECIFICATIONS (Continued)

REAR AXLE PINION ANGLES TO HORIZONTAL — F-150, F-250, F-350 (4x2)

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5560)	Curb Load Empty			
	mm	Inch	Lbs.	(Kg)		Ratio	Angle	Ratio	Angle
F-150	2967	117	1235	560	E6TA-LA	3.08/3.55	5-1/2"	3.50	6°
			1375	623	E6TA-RA	3.08/3.55	6°	3.50	6-3/4"
F-150	3378	133	1235	560	E6TA-LA	4.08/3.55	5-1/2°	3.50	6°
			1375	623	E6TA-RA	3.08/3.55	6°	3.50	6-3/4°
			1666	753	E6TA-NA	3.08/3.55	7-1/4°	3.50	6-1/2°
F-150	3526	139	1660	753	E6TA-NA	3.08/3.55	7-1/4°	3.50	6-1/2°
F-150	3937	155	1660	753	E6TA-NA	3.08/3.55	7-1/4°	3.50	6-1/2°
F-250 LD	3378	133	1700	771	E4TA-EA	ALL	7-1/4°		
			2450	1111	E4TA-HA	ALL	7-1/2°		
F-250 HD	3378	133	2590	1175	E3TA-AJA	ALL	6-1/4°		
SRW			2811	1275	E4TA-SA	ALL	6-1/4°		
F-250 HD	3937	155	2590	1175	E3TA-AJA	ALL	6-1/4°		
SRW			2811	1275	E4TA-SA	ALL	6-1/4°		
F-350 SRW	3378	133	2811	1275	E4TA-SA	ALL	6-1/4°		
F-350 DRW	3475	137	3225	1462	E5TA-YA	ALL	4-1/2°		
	4085	161	3225	1462	E5TA-YA	ALL	4-1/2°		

CE6459-2A

DRIVELINE ANGLES

ENGINE ANGLES TO HORIZONTAL

Engine F-150 — F-250 — F-350 (4x2) (4x4), and Bronco Couplingshaft, Driveshaft & Rear Axle Pinion Angles

Model	Wheelbase	Engine	Transmission	Angles
F-150 — F-250 — F-350 F-Super Duty (4x2) (4x4), Bronco	All	All Engines	All	5-1/2°

CE3913-2D

FRONT AXLE PINION ANGLES TO HORIZONTAL

F-150 — F-250 — F-350, BRONCO (4x4)

Model	Axle	Wheelbase		Curb Load Empty
		mm	Inch	
F-150 (4x4), Bronco	Dana 44 IFS	2260 2967 3378 3937	104 117 133 155	2-3/4°
F-250 (4x4) L D	Dana 44 IFSHD	3378 3937	133 155	6-3/4°
F-250-H D (4x4)	Dana 50 IFS	3378	133	6-3/4°
F-350 (4x4)	Dana 60 Mono Beam	3378 3475	133 137	4-1/2°

CE3918-2E

FRONT DRIVESHAFT ANGLES TO HORIZONTAL DANA 50 IFS FRONT DRIVE AXLE — F-250 H D (4x4)

Model	Wheelbase		Engine	Transmission	Curb Load Empty
	mm	Inch			
F-250 H D (4x4)	3378 3937	133 155	All	All	2-1/2°

CE3919-2F

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SPECIFICATIONS (Continued)

DRIVESHAFT — TORQUE LIMITS

Description	Bolt Size	Torque Limits	
		(Ft-Lb)	N•m
Bolt Yoke to Coupling Shaft	5/8-18 3/4-16 7/8-14 1-2	148-165① 175-240 250-300 160	201-222① 238-325 339-406 216
Nut — U-Joints — U-Bolt	5/16-18 3/8-18 7/16-20	8-15 17-26 30-40	11-20 24-35 41-54
Coupling Shaft Center Bearing Bracket-to-Support	7/16-20	37-54	51-73
Bolt — Drive Shaft U-Joint to Rear Yoke	1/2-20	90-110	123-149
Bolt and Nut — U-Joint Adapter to Rear Axle	1/2-20	60-70	82-94
Circular Flange Bolts	—	70-95	95-129
Driveshaft-to-Transfer Case Bolts	5/16-24	20-28	28-33
Driveshaft-to-Front and Rear Axle U-Bolt Nuts	5/16-18	8-15	11-20
Bolt — Strap②	5/16-24	25-30	34-41

NOTES:
①Dana Axle
②F-250 H.D. and F-350 with M5HD Transmission and F-Super Duty.

CE7160-2B

SPECIAL SERVICE TOOLS

Tool Number	Description
T74P-4635-C	U-Joint Tool
T63P-9171-A	Clamp Pliers
T68P-4602-A	Pinion Angle Level Gauge
T00L-4201-C	Dial Indicator
T00L-6565-AB	Cup Shaped Adapter
D78P-4201-B	Dial Indicator

CE4887-1E

ROTUNDA EQUIPMENT

Number	Description
006-01400	Strobe Balancer

CE7161-1A

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SECTION 15-61 Driveshaft—Single Type U-Joint

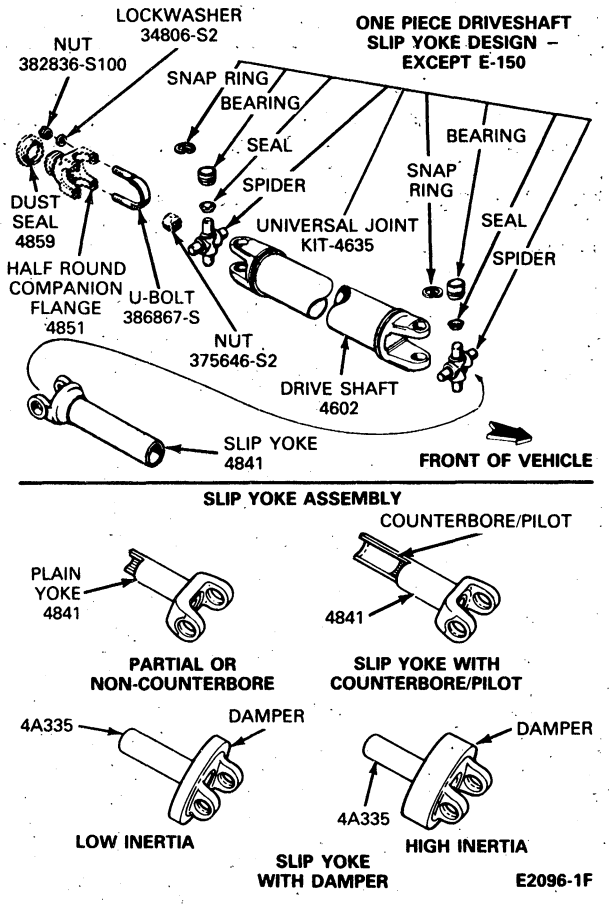
SUBJECT	PAGE
ADJUSTMENTS	
Adjustable Driveline Support Plate	15-61-5
Driveshaft Alignment	15-61-4
Driveshaft Runout and Balance	15-61-4
DESCRIPTION	15-61-1
DIAGNOSIS AND TESTING	15-61-4
DISASSEMBLY AND ASSEMBLY	
Snap Ring Type U-Joint	15-61-9
REMOVAL AND INSTALLATION	
Driveshaft (One Piece Models)	15-61-6
Driveshaft (2 or 3 Piece)	15-61-7
Driveshaft/Coupling Shaft (2 Piece)	15-61-6
SPECIFICATIONS	15-61-10
VEHICLE APPLICATION	15-61-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350, F-Super Duty Chassis Cab, Commercial Stripped Chassis, Motor Home Chassis and Bronco Vehicles.

DESCRIPTION

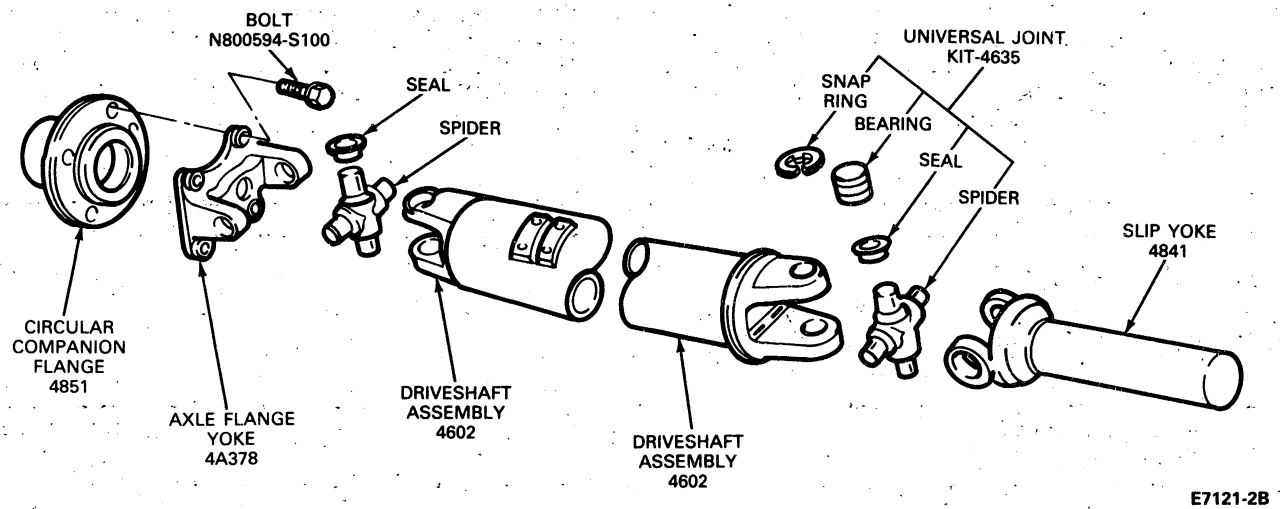
The driveshaft or coupling shaft is composed of the universal joints (U-joints), connecting shafts, attaching flanges, and slip yokes. The number of shafts and U-joints used depends on the vehicle application.



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DESCRIPTION (Continued)

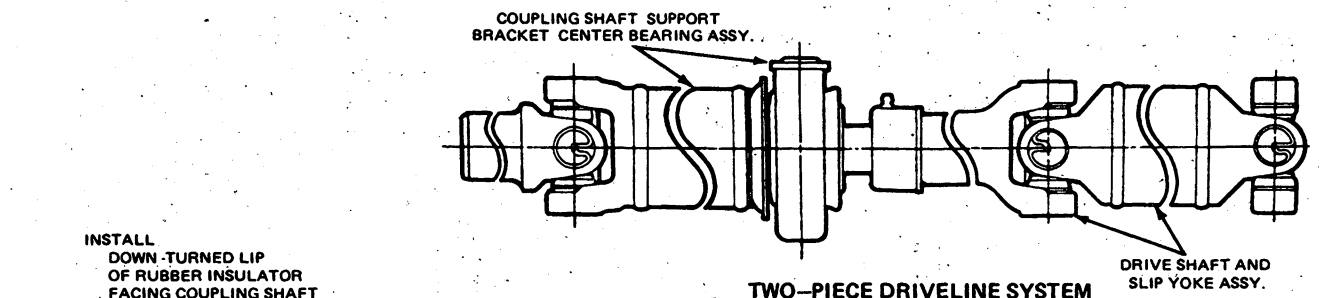
Some vehicles use a one piece slip-yoke type driveshaft. A universal joint and splined slip yoke are located at the transmission end of the shaft, where they are held in alignment by a bushing in the transmission rear extension. The splined slip yoke and transmission output shaft permits fore and aft movement of the driveshaft as the rear axle moves up and down. This provides smooth performance during vehicle operation. An oil seal at the transmission prevents leakage and protects the slip yoke from the dust, dirt and other harmful material. A second universal joint attached by two U-bolts is used where the driveshaft mates with the companion flange at the rear.



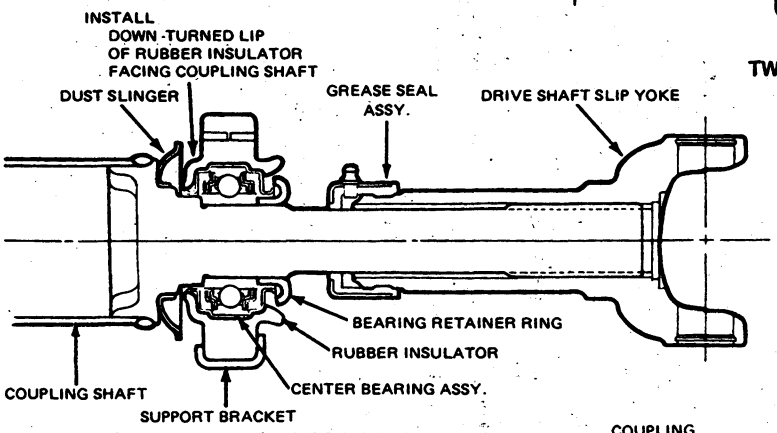
Others use a coupling shaft in conjunction with a driveshaft. Care must be taken to align the shafts as shown in the Figures. The two-piece driveline system incorporates a "necked down" coupling shaft stub with a "blindspline" feature which assures positive phasing action.

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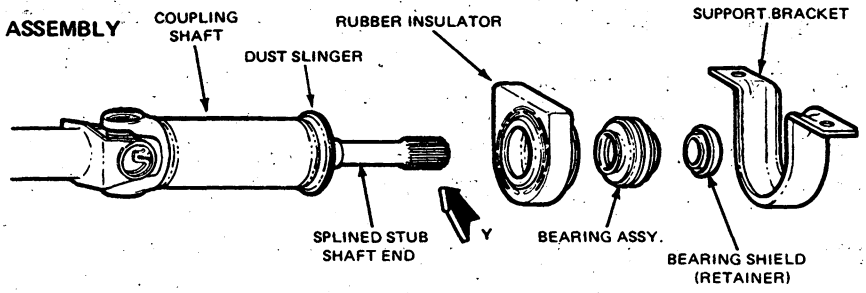
DESCRIPTION (Continued)

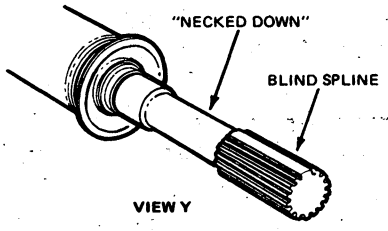


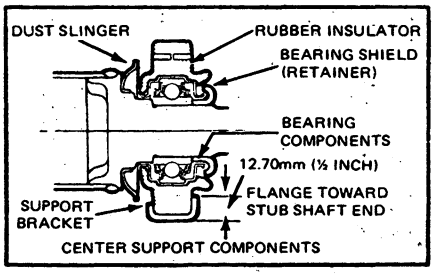
TWO–PIECE DRIVELINE SYSTEM



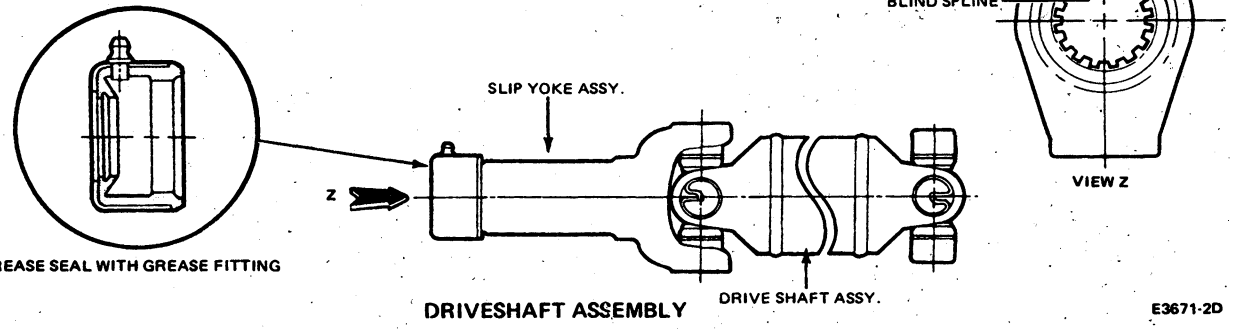
COUPLING SHAFT/CENTER BEARING ASSEMBLY







COUPLING SHAFT ASSEMBLY



DRIVESHAFT ASSEMBLY

E3671-2D

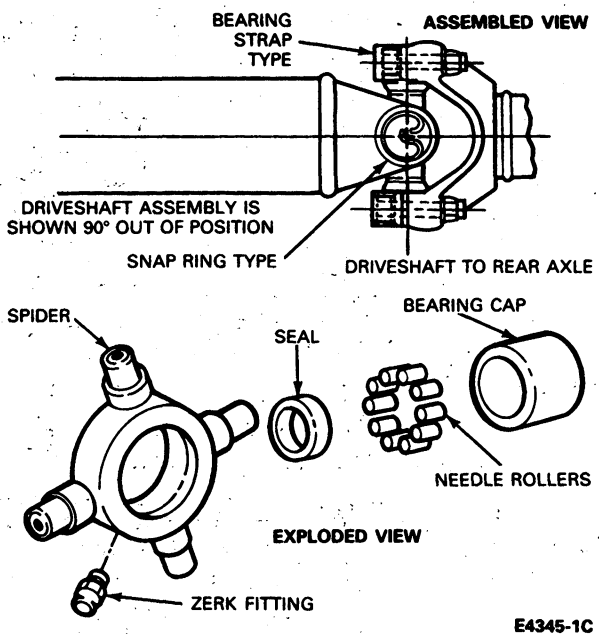
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DESCRIPTION (Continued)

All two piece driveshaft vehicles are equipped with center support bearings that are prelubricated and sealed for the bearing life.

All U-joints are of the lubed for life needle-bearing type. U-joints equipped with grease fittings should be lubricated at the specified intervals. The U-joint bearings are retained on the U-joints spiders by snap rings and U-bolts on some applications.

Driveshafts and coupling shafts are balanced; therefore, if the vehicle is being undercoated, the shafts and all open spline ares must be covered to prevent undercoating material from getting on the shafts.



DIAGNOSIS AND TESTING

Refer to Section 15-60, General Driveshaft Service and Section 18-01 Noise, Vibration and Harshness—Diagnosis.

ADJUSTMENTS

Driveshaft Runout and Balance

Refer to Section 15-60, General Driveshaft Service.

Driveshaft Alignment

Before adjusting components for correct driveshaft alignment, be sure to check the following:

1. Alignment of drivelines must be accomplished with the empty vehicle sitting on a hard level surface.
2. All angle measurements must be made on a surface or the component which is either parallel to or perpendicular to the center line of the component being measured.
3. Angle measurements must be made with either a spirit level or an inclinometer. Angle values given in Section 15-60 are nominal values with a tolerance of ± 1/4 degree.

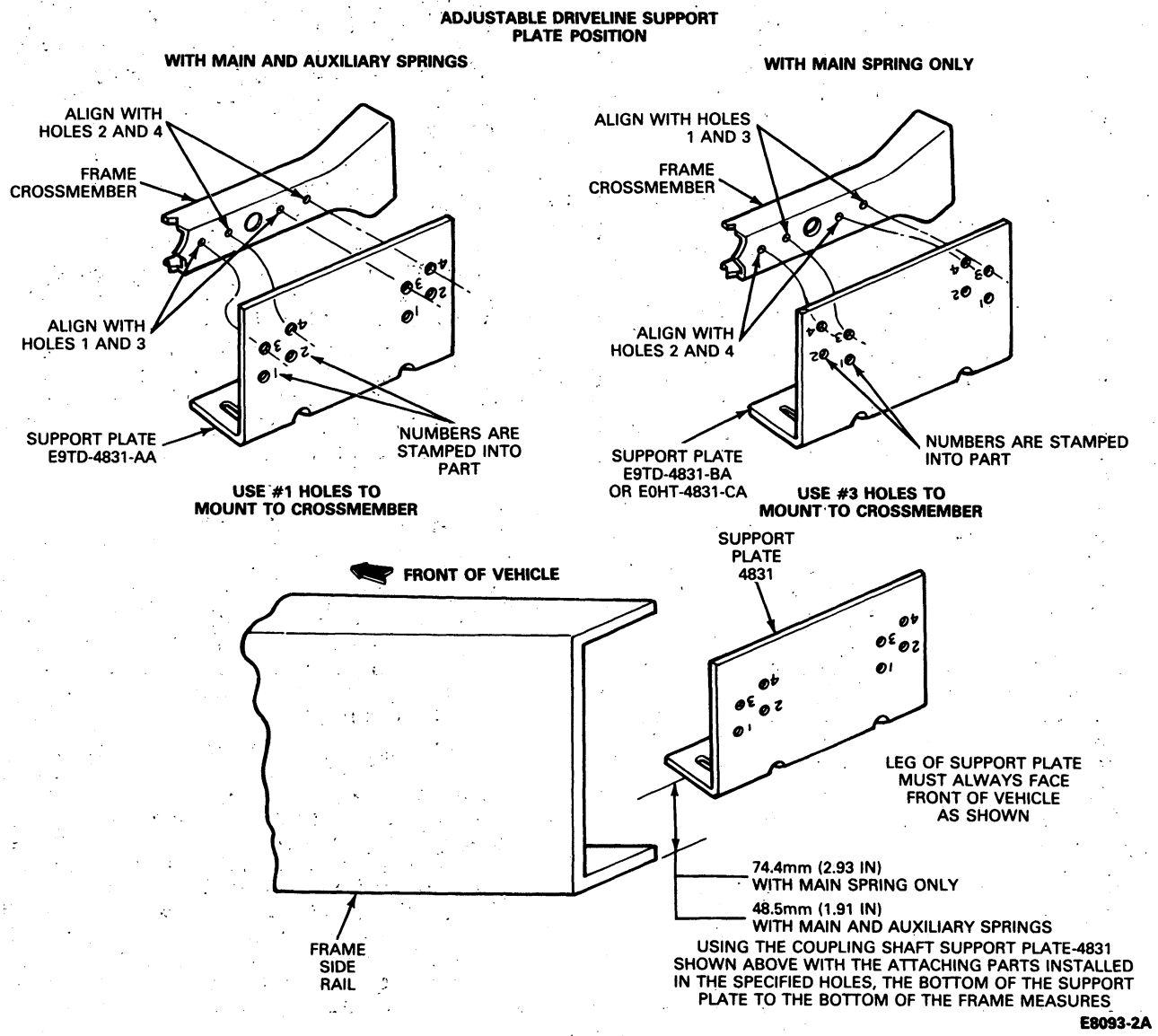
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ADJUSTMENTS (Continued)

Adjustable Driveline Support Plate

F-Super Duty Commercial Stripped Chassis and Motor Home Chassis

An adjustable driveline support plate is used. Although it can be mounted in any one of several positions, only one position is correct for a specific application. The correct position can be determined from the following illustration.



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REMOVAL AND INSTALLATION

Driveshaft/Coupling Shaft (2 Piece)

Except F-Super Duty, Commercial Stripped Chassis and Motor Chassis

To maintain driveline balance, mark the relationship of the rear driveshaft yoke and the rear axle companion flange before disassembly.

Removal

1. Disconnect the driveshaft from the rear axle companion flange and disconnect the driveshaft slip yoke from the coupling shaft yoke. Wrap tape around the loose bearing caps to prevent the bearings from falling off the universal joint spiders.
2. Remove the two center bearing support (coupling shaft) to the frame crossmember attaching bolts. Remove the coupling shaft assembly from the transmission extension. Install the appropriate tool in the transmission housing to prevent leaking.
3. Clean the male splines of the coupling shaft and driveshaft with a wire brush and a suitable solvent. Remove all hardened grease deposits, dirt or rust. Do not remove the blue plastic coating from male splines. Inspect for worm or galled splines. Remove any nicks, gouges or burrs using a file or emery cloth. If the driveshaft and slip yoke assembly.
4. Using a suitable cleaning fluid, clean all dirt from the slip yoke internal splines and the slip yoke assembly. Carefully inspect the slip yoke splines for wear or evidence of twisting. Check the clearance between the slip yoke splines and the driveshaft splines.
5. Wash all parts except the sealed center bearing and rubber insulator in suitable cleaning fluid. Do not immerse the sealed bearing in the cleaning fluid. Wipe the bearing and rubber insulator clean with a cloth dampened in cleaning fluid.

NOTE: Inspect the slip yoke seal, replace if necessary.

6. Check the center support bearing for wear or rough action by rotating the inner race while holding the outer race. If any wear or roughness is evident, replace the bearing.
7. Examine the rubber insulator for evidence of hardening, cracking, or deterioration. Replace if damaged in any way.

Installation

1. Lubricate the coupling shaft front slip yoke splines with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Remove the tool preventing leakage from the transmission housing. Install the front yoke of the coupling shaft assembly on the transmission output shaft. Do not allow the slip yoke assembly to bottom on the output shaft with excessive force.
2. Secure the center bearing support bracket to the frame crossmember with the center support attaching bolts. Tighten the bolts to specifications.
3. Apply a coating of Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent to entire splined stub shaft end of the coupling shaft assembly prior to the assembling of the driveshaft and the slip yoke.
4. Using a clean long handle (stencil type) brush apply Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent, spread evenly on all the female splines of the slip yoke.
5. Assemble the driveshaft slip yoke to the coupling shaft.
6. Connect the rear U-joint of the driveshaft to the rear axle companion flange and tighten the U-bolt nuts to specification.
7. Using a hand type grease gun, lubricate the driveshaft slip yoke through the zerk fitting with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

NOTE: To assure complete lubrication of the slip yoke splines, temporarily plug the vent hole in the "welch" type plug located at the yoke-end of the slip yoke while applying grease through the zerk fitting.

Driveshaft (One Piece Models)

Removal

1. To maintain driveline balance, if the yellow alignment marks are not visible, mark the relationship of the rear drive shaft yoke and the drive pinion flange of the axle in line with the drive shaft so that they may be re-installed in their original positions.
2. On all except E-150, remove the nuts retaining the U-bolts to the companion flange. On E-150, remove the bolts retaining the axle flange yoke to the circular companion flange. Disconnect the rear U-joint from the companion flange. Wrap tape around around the loose bearing caps to prevent them from falling off the spider. Pull the driveshaft toward the rear of the vehicle until the skip yoke clears the transmission extension housing and the seal. Install the appropriate tool in the housing to prevent lubricant leakage.

Installation

1. If the lugs on the axle companion flange are shaved or distorted so that the bearings slide, replace the flange.
2. Lubricate the yoke spline with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Remove the tool from the extension housing. Install the yoke on the transmission output shaft. Do not allow the yoke assembly to bottom on the output shaft with excessive force.

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REMOVAL AND INSTALLATION (Continued)

Install the driveshaft so that the index marks or the yellow mark (if visible) on the yoke (light side) is in line with the yellow mark on the companion flange. This prevents vibration which occurs when the balance of the shaft and balance of the axle pinion flange become additive instead of neutralizing. If a vibration exists, the driveshaft should be disconnected from the axle, rotated 180 degrees and re-installed.

3. On all except E-150, install the U-bolts and nuts that attach the U-joint to the companion flange. Tighten the U-bolt nuts to 11-20 N·m (8-15 ft-lbs). On E-150, install the bolts retaining the axle flange yoke to the circular companion flange. Tighten to 83-117 N·m (61-87 ft-lbs).

Driveshaft (2 or 3 Piece)

F-Super Duty Commercial Stripped Chassis and Motor Home Chassis Vehicles

Removal

1. Disconnect the driveshaft from the yoke at the rear axle.
2. Slide the driveshaft off the coupling shaft spines.
3. Working from the center support nearest to the rear of the vehicle, remove the two attaching bolts and support the bearing.
4. Remove the forward joint from its mating yoke.
5. Repeat Steps 3 and 4 until last shaft has been removed.
6. Thoroughly clean old grease and dirt from the driveshaft splines and then check the splines for wear, warpage and cracks. If the shaft is worn, warped, or cracked, replace it.

   Using a suitable cleaning fluid, clean all dirt from the slip yoke, slip yoke splines, and shaft splines.

   Do not clean the plastic coating on the male splines with a wire brush. Do not remove the plastic coating from the male splines.

   Carefully inspect the slip yoke splines for wear or evidence of twisting. Check the clearance between the slip yoke splines and the shaft splines.

   Wash all parts except the sealed ball bearing and rubber cushion in suitable cleaning fluid. **Do not immerse the sealed bearing in cleaning fluid.** Wipe the bearing and cushion clean with a cloth dampened with cleaning fluid.

   Check the bearing for wear of rough action by rotating the inner race while holding the outer race. If wear or roughness is evident, replace the bearing.

   Examine the rubber cushion for evidence of hardening, cracking, or deterioration. Replace it if it is damaged in any way.

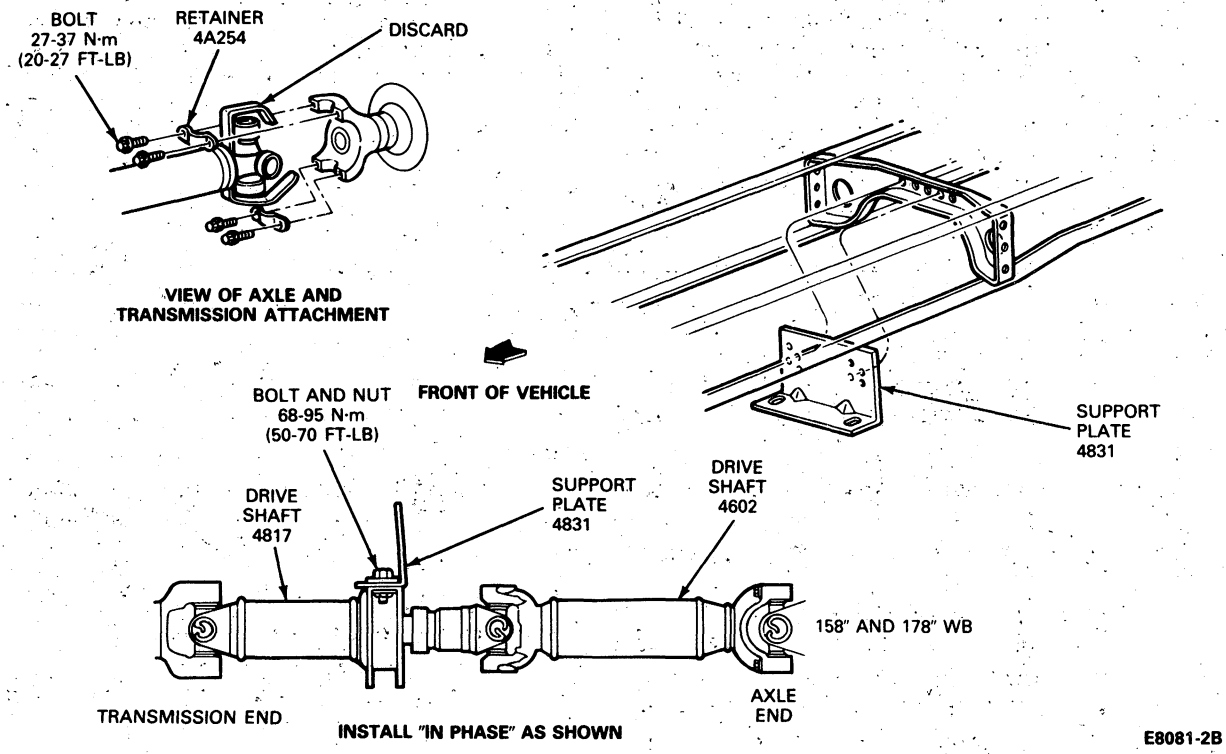
   Grease retainers and slingers are serviced only as part of the bearing assembly.

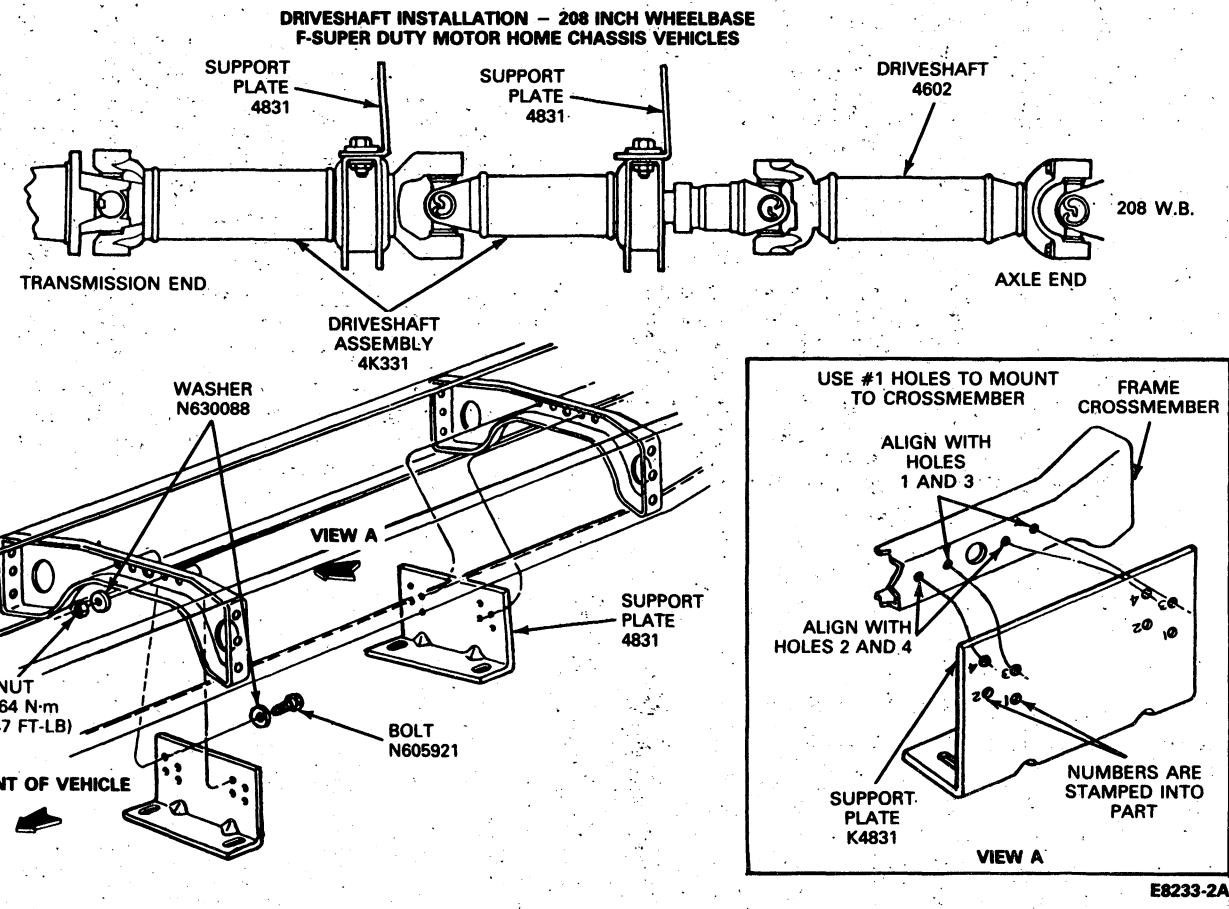
Installation

1. Connect the front joint of the coupling shaft to the yoke on the transmission. Tighten the bolts to specification found at the end of this Section.
2. Secure the center to the frame bracket with the center support and attaching bolts. Tighten the bolts to specification found at the end of this Section. Make sure that the center bearing is not twisted in the support plate.
3. If working on a vehicle with more than one coupling shaft, connect the rear shaft to the forward one, then install the remaining center support. All splines should be lubricated with High Temperature Grease, NLGI No, 2, ESL-M1C173-A or equivalent.
4. Connect the rear U-joints to the rear axle flange and tighten the bolts to specification. Be sure all driveshaft and coupling shaft yokes are properly in phase.

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REMOVAL AND INSTALLATION (Continued)





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DISASSEMBLY AND ASSEMBLY

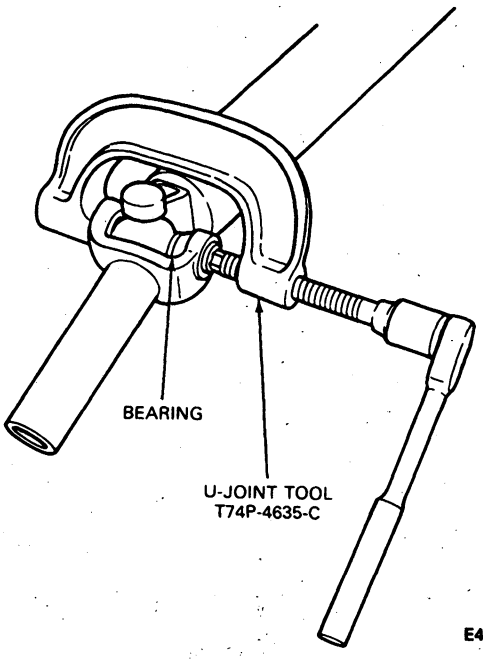
Snap Ring Type U-Joint

Disassembly

1. Place the driveshaft on a suitable workbench, being careful not to damage the tube.

CAUTION: Under no circumstances is the driveshaft assembly to be clamped in the jaws of a vice or similar holding fixture. Denting or localized fracture of the tube may result, which cause driveshaft failure during vehicle operation.

2. Remove the snap rings that retain the bearings in the yoke and in the driveshaft or coupling shaft.
3. Position the U-joint Tool, T74P-4635-C or equivalent on the shaft and press the bearing out of the yoke. If the bearing cannot be pressed all the way out of the flange, remove it with vise grip or channel lock pilers. Mark the yoke and the shaft to be sure that they will be reassembled in the same relative position.

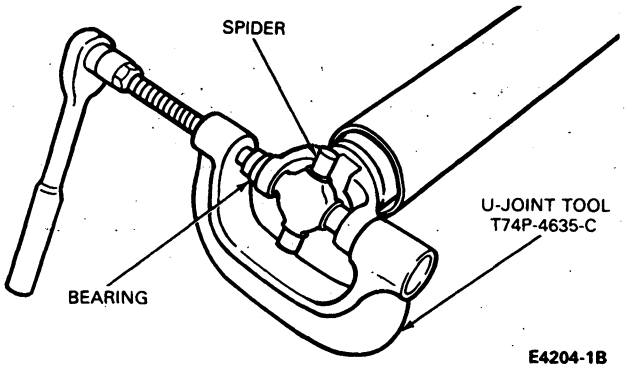


E4203-1B

4. Re-position the tool to press on the spider in order to remove the bearing from the opposite side of the flange.
5. Remove the flange from the spider.
6. Remove the bearings and spider from the driveshaft or coupling shaft in the same manner.

Assembly

1. Start a new bearing into the yoke at the rear of the driveshaft.
2. Position the spider in the rear yoke and press the bearing 6.35mm (1/4 inch) below the surface.
3. Remove the tool and install a new snap ring.
4. Start a new bearing into the opposite side of the yoke.
5. Install the U-Joint Tool T74P-4635-C or equivalent, and press on the bearing until the opposite bearing contacts the snap ring.



E4204-1B

6. Remove the toll and install a new snap ring.
7. Re-position the driveshaft or coupling shaft and install the spider and two new bearings in the front yoke in the same manner as the rear yoke.
8. Position the flange on the spider and install two new bearings and snap rings.
9. Check the joint for freedom of movement. if a bind has resulted from misalignment during the foregoing procedures, tap the ears of the driveshaft sharply to relieve the bind. Do not install the driveshaft if the U-joints show any signs of binding.

NOTE: The effort required for U-joint movement should not exceed 35 in-lbs when measured with a spring scale.

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SPECIFICATIONS

DRIVESHAFT — TORQUE LIMITS

Description	Bolt Size	Torque Limits	
		(Ft-Lb)	N-m
Bolt Yoke to Coupling Shaft	5/8-18 3/4-16 7/8-14 1-20	148-164① 175-240 250-300 160	201-222① 238-325 339-406 216
Nut-U-Joints — U-Bolt	5/16-18 3/-18 7/16-20	8-15 17-26 30-40	11-20 24-35 41-54
Coupling Shaft Center Bearing Bracket-to-Support	7/16-20	37-54	51-73
Bolt — Drive Shaft U-Joint to Rear Yoke	1/2-20	90-110	123-149
Bolt and Nut — U-Joint Adapter to Rear Axle	1/2-20	60-70	82-94
Bolt — Circular Flange to Pinion Flange	M12-1.25 x 27	61-87	83-118

①Dana

CE1989-2K

SPECIAL SERVICE TOOLS

Tool Number	Description
T74P-4635-C	U-Joint Bearing Remover and Installer

CE3681-1C

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SECTION 15-66 Driveshaft—Double Cardan-Type U-Joint

SUBJECT	PAGE
ADJUSTMENTS	15-66-1
DESCRIPTION	15-66-1
DIAGNOSIS AND TESTING	15-66-1
DISASSEMBLY AND ASSEMBLY	
Driveshaft U-Joints	15-66-1
REMOVAL AND INSTALLATION	
Driveshaft	15-66-1
SPECIFICATIONS	15-66-3
VEHICLE APPLICATION	15-66-1

VEHICLE APPLICATION

Bronco Rear Driveshaft and F-350 (4x4) Front Driveshafts.

DESCRIPTION

The rear driveshaft assembly is of the double Cardan type which incorporates two U-joints, a centering socket yoke, and a center yoke at the transfer case end of each shaft (Fig. 1). A single U-joint is used at the axle end of the shafts. All U-joints are "lube for life," and do not require scheduled maintenance lube for life.

All driveshafts are balanced. Therefore, if the vehicle is to be undercoated, cover the driveshaft to prevent undercoating material from getting on the shaft.

DIAGNOSIS AND TESTING

Refer to Section 15-60, General Driveshaft Service and Section 18-01, Noise, Vibration and Harshness for driveshaft diagnostic and testing procedures.

ADJUSTMENTS

For Adjustment procedures, refer to Section 15-60, General Driveshaft Service.

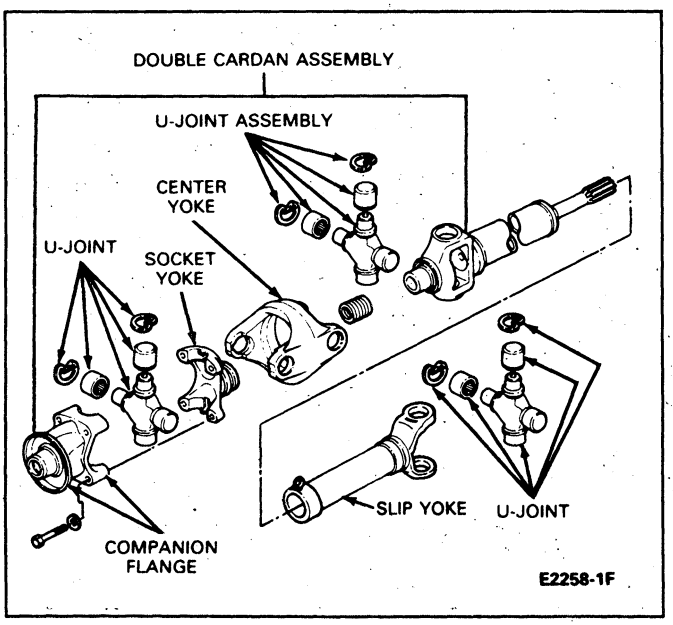


FIG. 1 Driveshaft Disassembled

REMOVAL AND INSTALLATION

Driveshaft

Removal

1. To remove the rear driveshaft on Bronco, disconnect the double Cardan U-joint from the flange at the transfer case and the single U-joint from the flange at the rear axle. Remove the driveshaft.
2. To remove the front driveshaft on F-350, disconnect the double Cardan joint from the flange at the transfer case and the single U-joint from the flange at the front axle. Remove the driveshaft.

Installation

1. To install the front driveshaft on F-350, position the single U-joint end of the driveshaft to the front axle and install the U-bolts and nuts.
2. Position the U-joint to the transfer case and install the four bolts and lockwashers.
3. Tighten the bolts at the transfer case to 28-33 N·m (20-28 ft-lbs), and the nuts at the front axle to 11-20 N·m (8-15 ft-lbs).
4. To install the rear driveshaft on Bronco, position the single U-joint end of the driveshaft to the rear axle and install the U-bolts and nuts.
5. Position the double Cardan joint to the transfer case and install the four bolts and lockwashers.
6. Tighten the bolts at the transfer case to 28-33 N·m (20-28 ft-lbs) and the nuts at the rear axle to 11-20 N·m (8-15 ft-lbs).

DISASSEMBLY AND ASSEMBLY

Driveshaft U-Joints

Disassembly of Double Cardan U-Joint

1. Place the driveshaft on a suitable workbench being careful not to damage the tube.
2. Mark the positions of the spiders, the center yoke, and the centering socket yoke as related to the stud yoke which is welded to the front of the driveshaft tube. **The spiders must be assembled with the bosses in their original position to provide proper clearance.**
3. Remove the snap rings that secure the bearings in the front of the center yoke.

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4. Position the U-Joint Tool, T74P-4635-C or equivalent as shown in Fig. 2. Thread the tool clockwise until the bearing protrudes approximately 9.525mm (3/8 inch) out of the yoke.
5. Clamp the bearing in a vise and tap on the center yoke as shown in Fig. 3 to free it from the bearing.
6. Lift the two bearing cups from the spider (Fig. 4).
7. Re-position the tool on the yoke and move the remaining bearing in the opposite direction so that it protrudes approximately, 9.525mm (3/8 inch) out of the yoke.

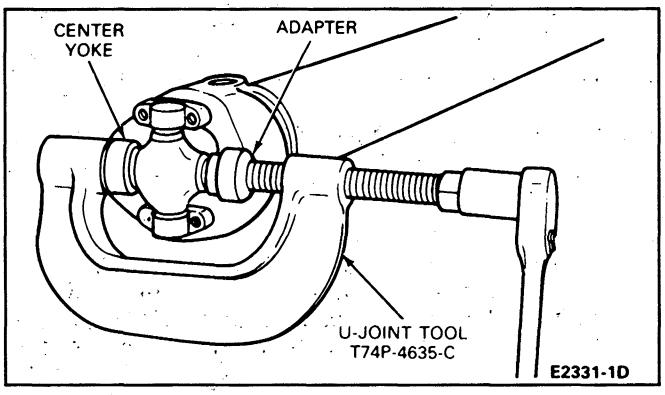


FIG. 2 Partially Pressing Bearing from Center Yoke

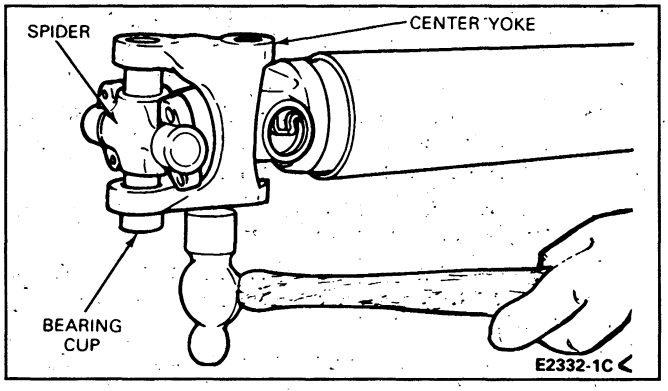


FIG. 3 Removing Bearing from Center Yoke

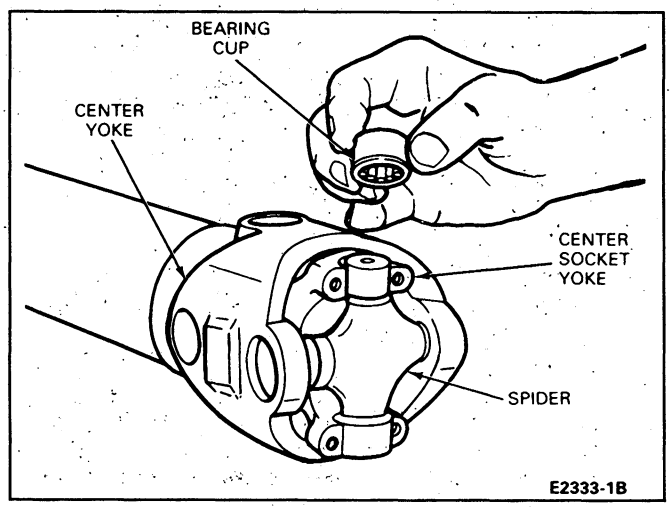


FIG. 4 Removing Bearing Cup from Centering Yoke Socket

8. Clamp the bearing in a vise. Tap on the center yoke to free it from the bearing (Fig. 3).
9. Remove the spider from the center yoke.
10. Pull the centering socket yoke off the center stud (Fig. 5). Remove the rubber seal from the centering ball stud.
11. Remove the snap rings from the center yoke and from the driveshaft yoke.
12. Position the U-Joint Tool T74P-4635-C or equivalent, on the driveshaft yoke (Fig. 6) and press the bearing outward until the inside of the center yoke almost contacts the slinger ring at the front of the driveshaft yoke. Pressing beyond this point can distort the slinger ring. The arrow in Fig. 7 illustrates the interference point.
13. Clamp the exposed end of the bearing in a vise and drive on the center yoke with a soft-faced hammer to free it from the bearing.
14. Re-position the tool and press on the spider to remove the opposite bearing.
15. Remove the center yoke from the spider.
16. Remove the spider from the driveshaft yoke in the same manner.
17. Clean all serviceable parts in cleaning solvent. If using a repair kit, install all of the parts supplied in

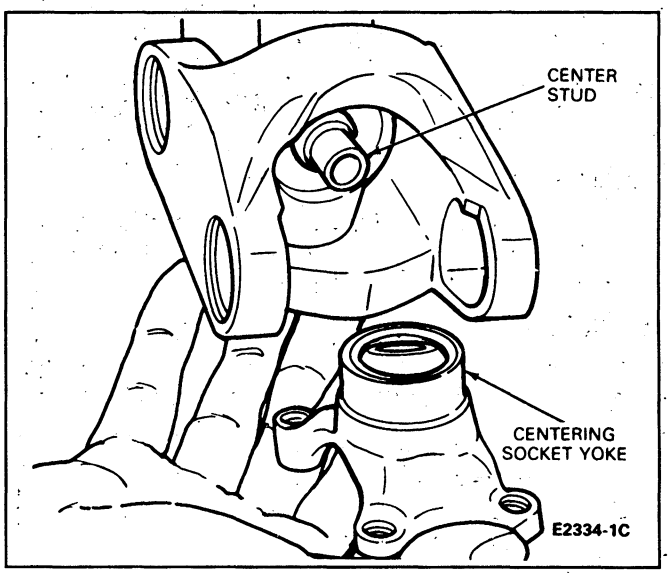


FIG. 5 Removing Center Socket Yoke

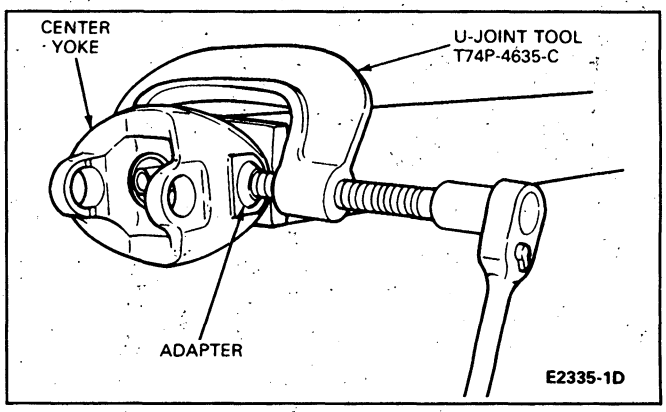


FIG. 6 Removing Bearing from Rear of Center Yoke

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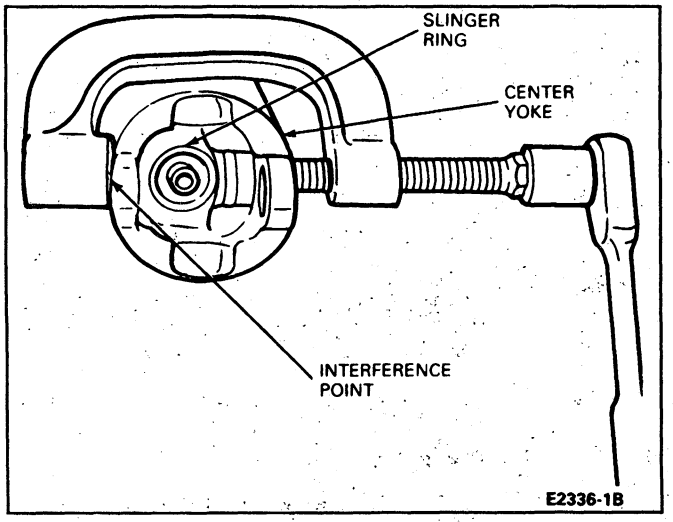


FIG. 7 Center Yoke Interference Point

the kit. If the driveshaft is damaged, replace the complete shaft to be assured of a balanced assembly.

Assembly

1. To assemble the double Cardan joints, position the spider in the driveshaft yoke. Make sure the spider bosses (or lubrication plugs on kits) will be in the same position as originally installed. Press in the bearing using U-Joint Tool, T74P-4635-C or equivalent. Install the snap rings.
2. Pack the socket relief and the ball with the Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, then position the center yoke over the spider ends and press in the bearing. Install the snap rings.
3. Install a new seal on the centering ball stud. Position the centering socket yoke on the stud.
4. Place the front spider in the center yoke. Make sure the spider bosses are properly positioned.
5. With the spider loosely positioned on center stop, proceed to seat the first pair of bearings into the centering socket yoke, then press the second pair into the centering yoke. Install the snap rings.
6. Apply pressure on the centering socket yoke and install the remaining bearing cup.

SPECIFICATIONS

TORQUE LIMITS

Nomenclature	Bolt Size and (ft-lbs)
Drive Shaft-to-Transfer Case Bolts	5/16-24 20-28 (28-33 N•m)
Drive Shaft-to-Front and Rear Axle U-Bolt Nuts	5/16-18 8-15 (11-20 N•m)

CE2241-1E

SPECIAL SERVICE TOOLS

Tool No.	Description
T74P-4635-C	U-Joint Bearing Removal-Installation Tool

CE3682-1C

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SECTION 15-67 Front Driveshaft

SUBJECT	PAGE
ADJUSTMENTS	15-67-1
DESCRIPTION	15-67-1
DIAGNOSIS AND TESTING	15-67-1
DISASSEMBLY AND ASSEMBLY	
Front Driveshaft	15-67-2
REMOVAL AND INSTALLATION	
Front Driveshaft	15-67-1
SPECIFICATIONS	15-67-4
VEHICLE APPLICATION	15-67-1

VEHICLE APPLICATION

All F-150—F-350 (4x4) and Bronco Vehicles.

DESCRIPTION

The front driveshaft connects the power flow from the transfer case to the front drive axle. It incorporates two single cardan universal joint (U-joint) assemblies, (one double cardan on F-350), a driveshaft with a splined stub shaft end, and a boot with two clamps (one large and one small) (Figs. 1 and 2). The F-150, F-250, and Bronco driveshafts must have a length of 35.10 inches (892mm) for C6 and M5HD(ZF) transmissions, 36.10 inches (917mm) for AOD transmissions, and 38.50 inches (978mm) for M5OD(R2) transmissions, from the centerline of the U-joint in the front yoke to the centerline of the U-joint in the rear yoke when in its free state. For F-350 models, the driveshaft must have a length of 819mm (32.25 inches) for C6 transmissions, 970mm (38.19 inches) for E40D transmissions, 832mm (32.75 inches) for M5HD(ZF) transmissions on 7.5L/ 7.3L, and 905.8mm (35.66 inches) for M5HD(ZF) transmissions on 5.8L, from the centerline of the front U-joint to centerline of rear U-joint when in its fully compressed (shortest) state.

NOTE: Whenever the vehicle is raised on a hoist, inspect the rubber boot for rips or tears. Replace if required.

All front driveshaft assemblies are balanced. If the vehicle is to be undercoated, cover the driveshaft and U-joints to prevent application of any undercoating material.

DIAGNOSIS AND TESTING

Refer to Section 15-60, General Driveshaft Service and Section 18-01, Noise, Vibration and Harshness Diagnosis for diagnostic and testing procedures.

ADJUSTMENTS

For Adjustment procedures, refer to Section 15-60, General Driveshaft Service.

REMOVAL AND INSTALLATION

Front Driveshaft

Removal

1. To maintain driveshaft balance, mark the rear slip yoke in relation to the transfer case yoke for correct positioning during installation.
2. Remove the nuts and U-bolts, (bolts for F-350 at transfer case) that connect the rear slip yoke to the transfer case and the front yoke to the front drive axle.
3. Remove the driveshaft from the vehicle. Wrap tape around the lose bearing caps to prevent the bearings from falling out of the U-joint spiders.

Installation

NOTE: If the slip yoke and rubber boot have been separated from the splined stub shaft on the driveshaft refer to Front Driveshaft-Disassembly and Assembly in this Section.

1. Install the driveshaft so the marks on the rear slip yoke and transfer case yoke are in alignment.

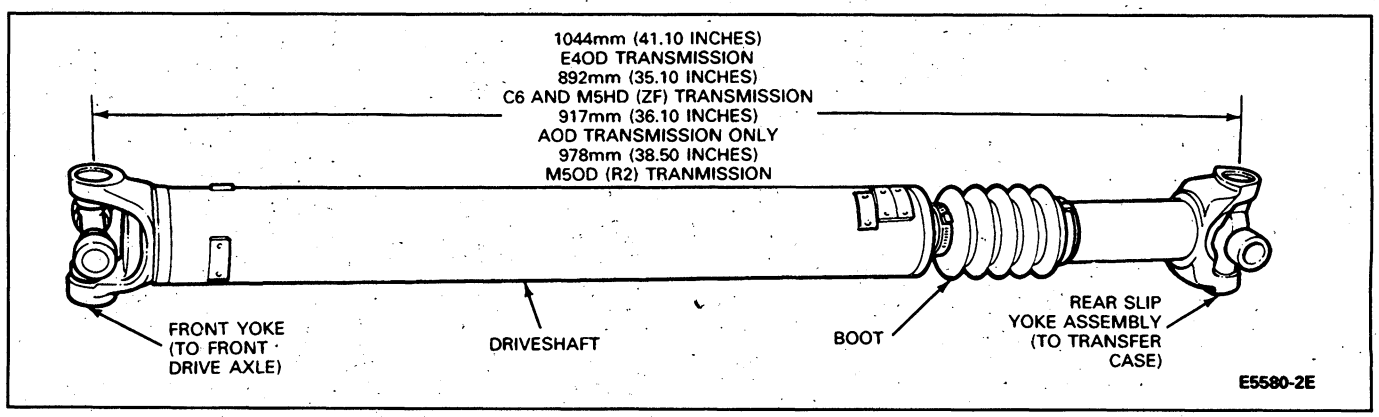


FIG. 1 Front Driveshaft—F-150—F-250 (4x4) and Bronco (4x4)

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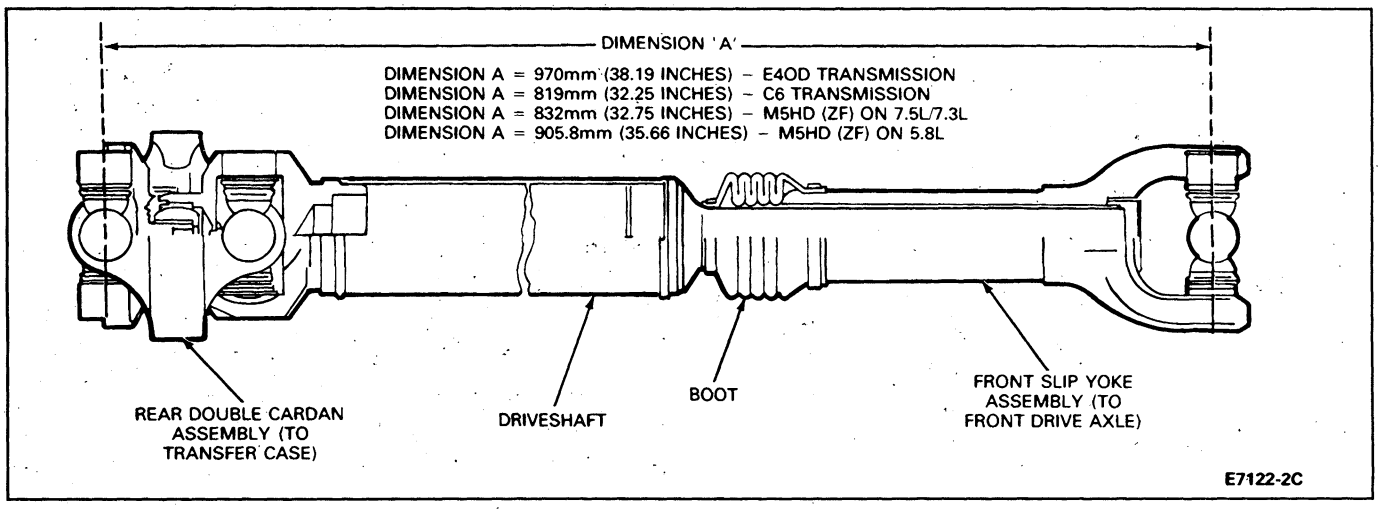


FIG. 2 Front Driveshaft—F-350 (4x4)

2. Install the nuts and U-bolts that retain the rear slip yoke to the transfer case yoke. Tighten nuts to 11-20 N·m (8-15 ft-lbs). On F-350 tighten bolts to 28-33 N·m (20-28 ft-lbs).
3. Install the nuts and U-bolts that retain the front driveshaft yoke to the front drive axle yoke. Tighten nuts to 11-20 N·m (8-15 ft-lbs).

DISASSEMBLY AND ASSEMBLY

Front Driveshaft

Refer to Fig. 3

Disassembly

1. With the front driveshaft assembly on a bench, cut the boot clamps with sidecutters (Fig. 4). Remove and discard the clamps.
2. Separate the rear slip yoke from the splined stub shaft on the driveshaft.
3. Remove the rubber boot. Inspect the boot for rips or tears and replace if required.

   If during inspection, the driveshaft boot is found to be cracked or split, the grease should be checked for contamination (Fig. 5). If driveshaft was operating satisfactorily and the grease does not appear to be contaminated, add grease as described in the assembly portion of this procedure and replace the boot. If the grease appears contaminated, disassemble the driveshaft and inspect the stub shaft and slip yoke for wear.
4. If required, remove and install the U-joints as described under Snap Ring Type U-Joint in the Disassembly and Assembly portion of Section 15-61, Driveshaft-Single Type U-Joint (Section 15-66 for F-350 with double cardan type U-joint).

Assembly

1. Install the rubber boot with the small diameter side spacing the splined stub shaft on the stub shaft as far as it will go (Fig. 6).

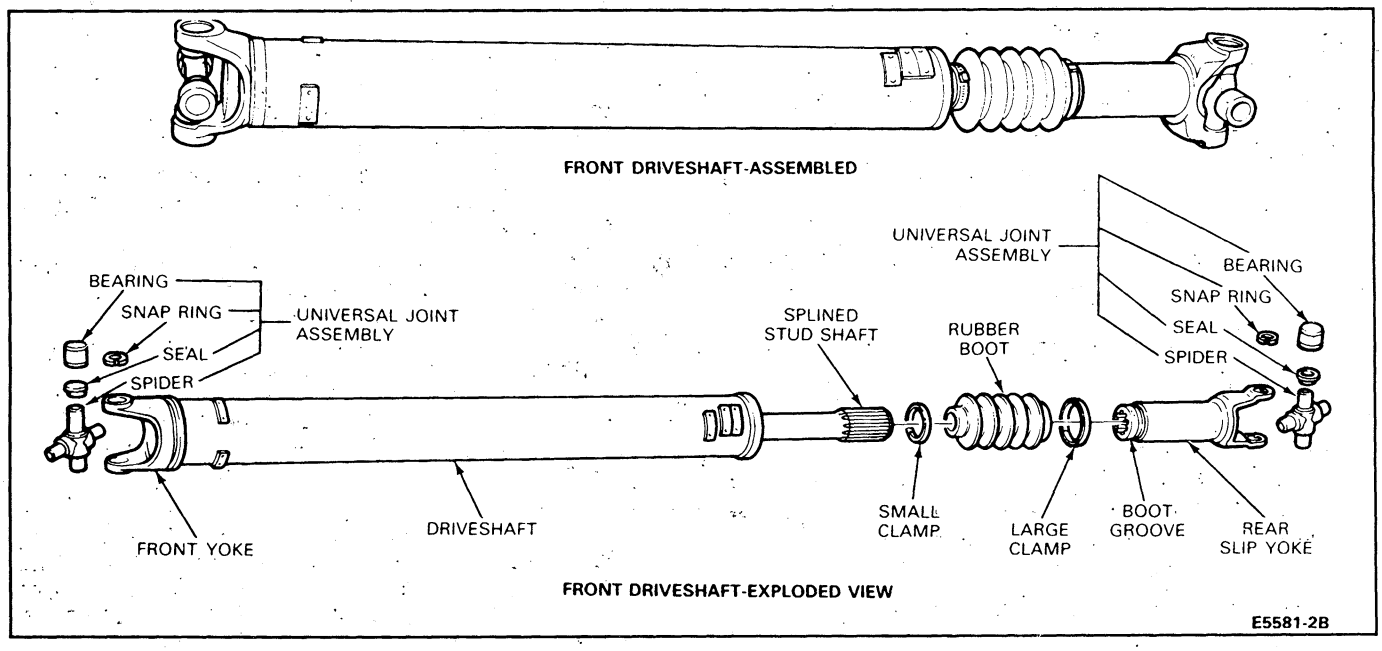


FIG. 3 Front Driveshaft—Exploded View

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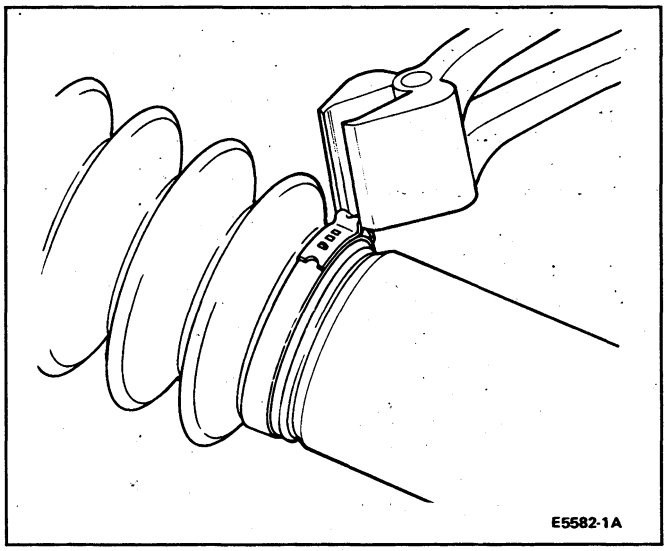


FIG. 4 Clamp Removal

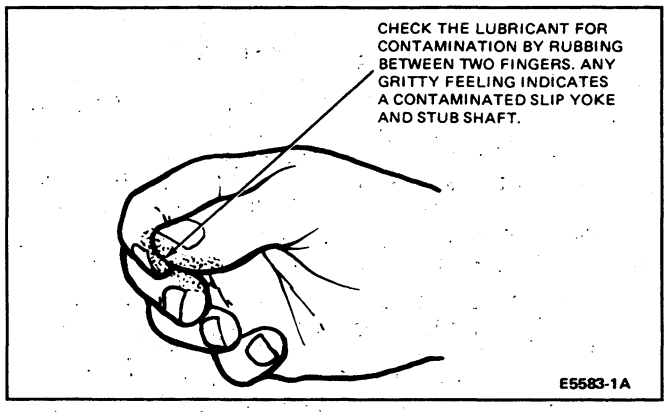


FIG. 5 Inspecting Grease for Contamination

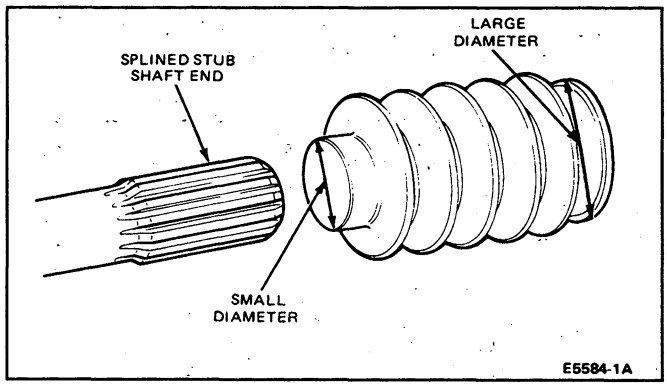


FIG. 6 Rubber Boot Installation

2. Install a new small clamp and crimp the clamp using Clamp Pliers, T63P-9171-A or equivalent (Fig. 7).

   NOTE: Use ORIGINAL EQUIPMENT CLAMPS when installing boots. Use of other clamps may cause the driveshaft to become out of balance.

3. Pull the boot towards the driveshaft and coat the stub shaft splines with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.

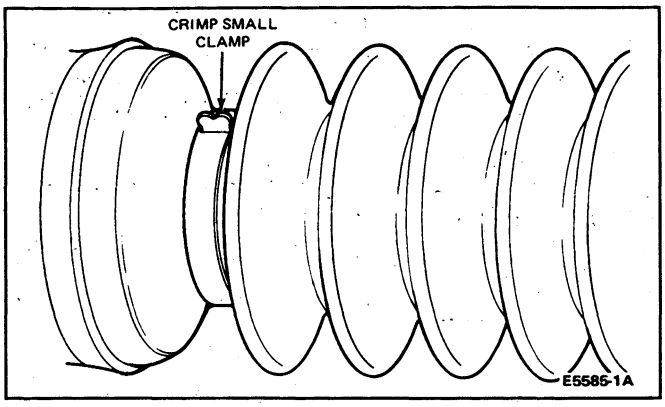


FIG. 7 Clamp Installation

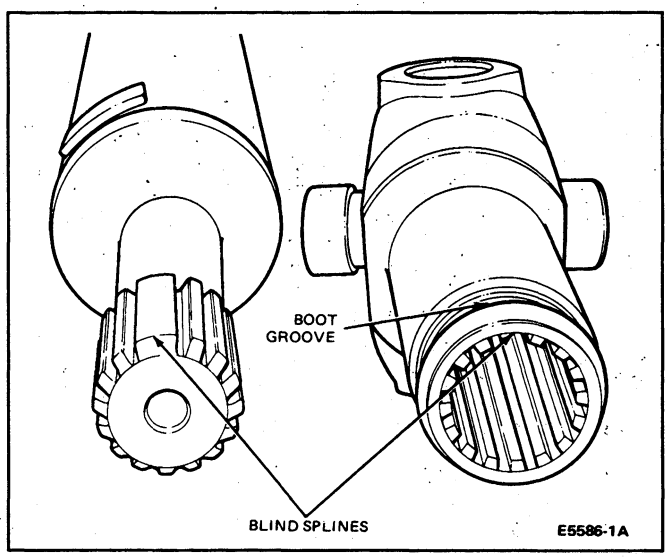


FIG. 8 Blind Spline Alignment

4. Fill the boot with approximately 10 grams of Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
5. Slide the large clamp onto the barrel of the rear slip yoke.
6. Align the blind splines on the splined stub shaft and in the rear slip yoke as shown in Fig. 8. Push the slip yoke onto the stub shaft, making sure both blind splines are matched.
7. Remove all excess grease from the boot and slip yoke surfaces. Position the boot over the slip yoke boot groove.
8. Move the slip yoke in or out (making sure the boot stays in its groove) as required to adjust the front driveshaft to a length of 892mm (35.10 inches) for all except AOD transmissions and 917mm (36.10 inches) for AOD transmissions. This distance is measured from the centerline of the U-joint assembly in the front yoke to the centerline of the U-joint assembly in the rear slip yoke (Fig. 1). For F-350 double cardan type, collapse the driveshaft to its shortest length (Fig. 2).
9. Before installing the new large clamp, make sure that any air pressure which may have built up in the boot is relieved. Insert a dulled screwdriver between the boot and the rear slip yoke and allow the trapped air to escape ("burp") from the boot (Fig. 9). THE AIR MUST BE RELEASED ONLY

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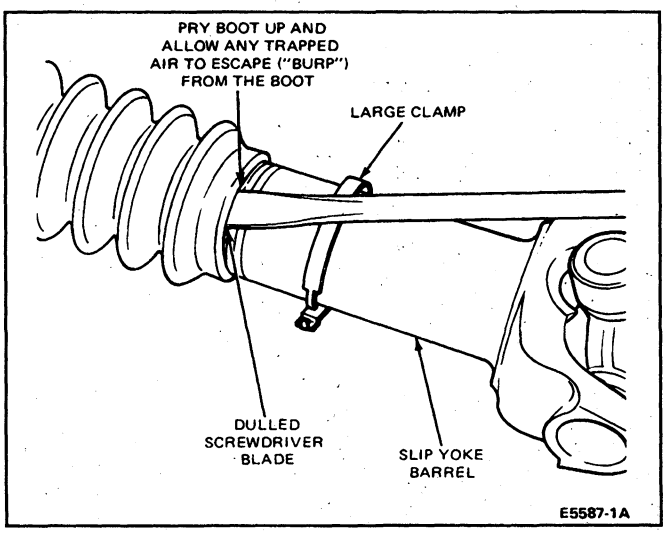


FIG. 9 Releasing Air from Boot

AFTER THE DRIVESHAFT IS SET AT THE SPECIFIED LENGTH.

10. Position the new large clamp over the boot and groove in the slip yoke. Crimp the clamp with Clamp Pliers, T63P-9171-A or equivalent.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Tool Number	Description
T63P-9171-A	Clamp Pliers

CE6464-1B

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CLUTCH AND MANUAL TRANSMISSION

GROUP 16

(7000)

SECTION TITLE	PAGE
BORG-WARNER 13-56 ELECTRONIC SHIFT TRANSFER CASE	16-80-1
BORG-WARNER 13-56 TRANSFER CASE—MANUAL SHIFT	16-81-1
BORG-WARNER 1345 TRANSFER CASE	16-86-1
CLUTCH	16-02-1
FOUR-SPEED OVERDRIVE TRANSMISSION	16-30-1
GENERAL CLUTCH SERVICE	16-01-1
GENERAL MANUAL TRANSMISSION SERVICE	16-10-1
HYDRAULIC CLUTCH SYSTEM	16-04-1
MAZDA M5OD FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION	16-20-1
MODEL S5-42 ZF MANUAL TRANSMISSION	16-34-1
WARNER T-18 FOUR-SPEED TRANSMISSION	16-23-1

SECTION 16-01 General Clutch Service

SUBJECT	PAGE
ADJUSTMENTS	
Alignment Correction (Warner Transmission)	16-01-11
Dowel Replacement Procedure	16-01-11
Flywheel Housing Alignment (Warner Transmission)	16-01-9
Inspection and Alignment Procedure (Warner Transmission)	16-01-9
CLEANING AND INSPECTION	
Clutch Disc	16-01-12
Clutch Release Bearing	16-01-11
CLEANING AND INSPECTION (Cont'd)	
Crankshaft End Play Check	16-01-12
Flywheel Face Runout	16-01-13
Flywheel Runout	16-01-12
Pilot Bearing Assembly	16-01-13
Pressure Plate and Cover	16-01-12
DIAGNOSIS AND TESTING	
Diagnosis Guides	16-01-2
Testing Procedures	16-01-8
SPECIFICATIONS	16-01-13
VEHICLE APPLICATION	16-01-1

VEHICLE APPLICATION

Applies to Bronco, E-150, F-150, -250, -350, F-Super Duty Chassis Cab and Commercial Stripped Chassis Vehicles Equipped with Manual Transmissions.

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DIAGNOSIS AND TESTING

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in clutch diagnosis.

CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch thud	1. Excessive engine crankshaft end play.	1. Repair engine per specifications.
Clutch vibration (torsional) vehicle moving — 8 cyl. engine @ road speed 49-96 km/h (30-60 mph) 6 cyl. engine @ 49-96 km/h (30-60 mph)	1. Incorrect clutch disc installed (wrong friction lag specifications). 2. After market (off-brand) clutch disc installed. 3. Malfunctioning engine. 4. Incorrect installation of coupling shaft or drive shaft assembly.	1. Install specified clutch disc. 2. Install specified clutch disc. 3. Check engine performance, tune up engine. 4. Install correct parts. Align driveline.
Clutch linkage clicking (popping noise)	1. Clutch release lever requires lubrication.	1. Lubricate conical seat of release lever with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) lubricant or equivalent. Reposition override release lever.
Gear clash	1. Clutch disc warped or bent preventing full release. 2. Warped pressure plate. 3. Transmission housing misalignment. 4. Pressure plate attaching bolts loose. 5. Air in hydraulic system.	1. Replace clutch disc. 2. Replace pressure plate. 3. Realign housing. 4. Tighten bolts. 5. Bleed clutch hydraulic system.
Gear jump-out	1. Transmission housing misalignment.	1. Realign housing.
Noise — clutch fully engaged	1. Transmission problem.	1. Refer to transmission problems diagnosis for corrective action.
Start-up chatter during light clutch engagement in low or reverse	1. Engine roughness.	1. Tune engine. Set idle speed to specifications.

CC5213-2E

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Start-up chatter during light clutch engagement in low or reverse (Cont'd.)	2. Throttle linkage improperly adjusted.	2. Readjust.
	3. Engine misaligned. Not properly seated on mounts.	3. Loosen engine mount bolts, align and center engine so engine mounts center in teardrop holes.
	4. Body mounts improperly tightened (incorrect torque).	4. Check for correct front and rear body mounts, proper installation and bolt torque.
	5. Oil or grease on clutch disc.	5. Correct leak, replace disc, clean pressure plate and flywheel friction surfaces with clean solvent (alcohol base). Deglaze flywheel.
	6. Glazed flywheel surface.	6. Deglaze flywheel surface with coarse emery cloth, stroke parallel to machining lines.
	7. Clutch disc warped or bent (little or no reserve).	7. Replace clutch disc.
	8. Pressure plate attaching bolts loose or missing.	8. Replace broken or missing bolts, tighten to specification.
	9. Loose engine mount attaching bolts.	9. Tighten bolts.
	10. Loose transmission and/or clutch housing attaching bolts.	10. Tighten bolts.
	11. Clutch housing loose or misaligned.	11. Realign.
	12. Pressure plate fingers bent, out-of-plane or sticking (will not return hung-up).	12. Replace pressure plate.
	13. Release lever (fork) bent, broken or cracked.	13. Replace release lever.
Clutch inoperative	1. Release lever broken.	1. Replace release lever.
	2. Pressure plate worn or warped.	2. Replace pressure plate.
	3. Clutch hydraulic system leaking externally or internally.	3. Replace hydraulic component that leaks externally, or replace clutch master cylinder if suspected of internal leakage.
	4. Disc worn or warped.	4. Replace clutch disc.
	5. Flywheel worn or warped.	5. Re-face or replace flywheel.
Clutch noise squeal (engine idling — clutch released when cold).	1. Pilot bearing in crankshaft not square with crankshaft (misaligned).	1. Replace pilot bearing — seat properly in crankshaft, **do not grease,** clean input shaft pilot and apply coat of light oil for initial lube only.

CC5214-2C

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch noise squeal (engine idling — clutch released when cold). (Cont'd.)	2. Release bearing.	2. Replace release bearing.
	3. Clutch housing misalignment (pilot bore and face runout).	3. Align housing.
Squeak (engine off)	1. No lube on release rod bushings or clutch pedal shaft bushings.	1. Replace all worn bushings. Apply Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) lubricant or equivalent to inside and outside of bushing prior to assembly.
	2. No lube on release lever at fulcrum and/or release bearing hub retaining clips.	2. Remove release lever and bearing. Daub Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) lubricant or equivalent under leading edge of retaining clips of release bearing and in fulcrum seat of release lever.
	3. Loose steering column cover or brake and clutch pedal support bracket at instrument panel.	3. Tighten all attaching parts to specifications.
	4. Clutch master cylinder push rod rubbing in rubber boot.	4. Lubricate boot with silicon lubricant spray.
Scrubby pedal action and feel	1. No lube at release lever fingers or rear face of release bearing.	1. Daub Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) lubricant or equivalent at leading edge of release lever fingers.
	2. No lube in release bearing hub. Scored transmission input shaft retainer.	2. Replace release bearing and transmission input shaft retainer. Fill annular groove of release bearing hub with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) lubricant or equivalent.
	3. Clutch pedal binding in pedal support.	3. Lubricate clutch pedal shaft, bushings and pedal support.

CC5215-2B

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Rattle — engine idling, clutch engaged or on light engagement	1. Pedal hang-up (pedal does not return to stop).	1. Dry pedal shaft — lube pedal shaft and bushings. Check for broken or missing clutch pedal assist spring. Replace if necessary.
Slipping clutch	1. Oil on disc assembly. (Also caused clutch clatter).	1. Replace disc after washing flywheel and pressure plate friction surfaces with clean solvent. Deglaze flywheel and pressure plate.
	2. Broken pressure plate.	2. Replace pressure plate.
	3. Worn clutch facings.	3. Replace facings or complete driven disc assembly.

CC5216-2B

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch "squeaks" or "scrapes" when pedal is depressed.	1. Clutch linkage under dash panel shows lack of lubrication, binding, interference(s), excessive wear or misalignment.	1. Lubricate, repair or replace as required, then road test.
	2. Linkage inside clutch housing shows lack of lubrication, binding, excessive wear or misalignment.	2. Lubricate, repair or replace as required, then road test.
	3. Pressure plate binds or has interference, broken or bent Belleville spring.	3. Replace pressure plate, then road test.
	4. Other (1, 2, and 3 OK).	4. Perform "Inspection and Alignment Procedure — All Models" (Section 16-01, General Clutch Service). Repair as required, then road test.
Clutch chatters during starts.	1. Engine rough idle hesitation during acceleration.	1. Adjust or correct engine idle as required.
	2. Engine misaligned, not properly seated on mounts.	2. Align and center engine mounts in tear drop holes.
	3. Engine, transmission, or cab mounts misaligned and/or loose.	3. Align, replace, and tighten mounts as required.
	4. Release bearing or transmission retainer inadequately lubricated, misaligned, worn or galled.	4. Replace release bearing or transmission retainer as required.
	5. Flywheel housing bore and face out of alignment.	5. Correct per shop manual procedure in this Section.
	6. Loose or missing pressure plate attaching bolts.	6. Replace and/or tighten to specification.
	7. Bent or out-of-plane pressure plate fingers.	7. Replace pressure plate if release fingers are more than 0.060 inch out-of-plane.
	8. Clutch disc contaminated with oil.	8. Correct leak, replace disc and clean pressure plate as required.
	9. Clutch disc warped, cracked, or friction material loose.	9. Replace disc.
	10. Pressure plate warped or shows hot spots.	10. Replace pressure plate.
	11. Flywheel warped, or discolored (excessive heat).	11. Reface or replace flywheel.
NOTE: A light chatter or shudder in the vehicle when engaging the clutch at light throttle is a normal occurrence. This condition results from the new lower numerical axle ratio. It may be more pronounced in heavily loaded vehicles. Drive train function and durability are not affected by this chatter condition. Therefore, drive train components, particularly clutches, should not be replaced or rebuilt in attempts to eliminate this condition.		

CC4559-2E

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch noisy.	1. Release bearing worn or damaged. 2. Pressure plate release fingers worn or damaged. 3. Flywheel housing and engine crankshaft out of alignment. 4. Transmission front extension not properly engaged.	1. Replace bearing. 2. Replace pressure plate assembly. 3. Align or replace housing as required. 4. Repair as required.
Clutch slips after the pedal is fully released.	1. Clutch pedal linkage binding (outside of flywheel housing). 2. Transmission input shaft bearing retainer and pressure plate worn, damaged or lack lubrication. Clutch disc worn.	1. Lubricate, repair and replace linkage parts as required. 2. Lubricate or replace parts as required.
Clutch does not disengage completely.	1. Clutch linkage and bushings (outside of flywheel housing) worn, cracked or bent. 2. Damaged or worn clutch disc, pressure plate or release lever. 3. Damaged or worn crankshaft pilot bearing. 4. Clutch disc hub spline does not move freely on transmission input shaft spline. 5. Clutch hydraulic system inoperative. 6. Incorrect clutch disc installed.	1. Repair or replace the damaged or worn bushings, levers and rods. 2. Replace damaged or worn parts as required. 3. Replace bearing as required. 4. Repair or replace parts as required. 5. Replace clutch hydraulic system. 6. Replace clutch disc.

CC4560-2C

CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch pedal hangs up at top of stroke.	1. Pedal or cross shaft lever interfering with dashboard wiring. 2. Broken or missing clutch pedal assist spring. 3. Loose clutch pedal attaching nut. 4. Improperly positioned cross shaft lever. 5. Release bearing and hub grinding on transmission input shaft bearing retainer. 6. Hydraulic System (piston) binds internally.	1. Reroute or tie interfering wires. 2. Replace spring. 3. Tighten nut. 4. Replace cross shaft lever. Refer to Section 16-04 Hydraulic Clutch System for push rod length adjustment. 5. Lubricate bearing hub with Ford Long Life Lubricant C1AZ-19590-BA (ESA-M1C75-B), or equivalent. Replace transmission input shaft retainer if worn. 6. Replace master cylinder or slave cylinder as required.
Heavy pedal efforts on a fast pedal stroke, but normal pedal efforts on a slow pedal stroke.	1. Restriction in hydraulic tubing.	1. Replace hydraulic tubing.

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SYMPTOM: CLUTCH NOISE

TEST STEP		RESULT	ACTION TO TAKE
1.0	PEDAL ACTION (ENGINE OFF)		
	With engine off, check for noise and binding condition when pedal is depressed and then released.	OK	GO to 2.
		Noise/Binding	GO to "Squeaks" or "Scrapes" Diagnosis Charts.
2.0	PEDAL ACTION (ENGINE RUNNING)		
	With engine running, depress pedal.(See note below.)	OK	GO to 3.
		Noise	GO to 4.
3.0	CLUTCH ENGAGEMENT		
	With engine running, check for squealing noise when engaging clutch.	OK	ROAD TEST.
		Squealing Noise	GO to 5.
4.0	RELEASE BEARING/PRESSURE PLATE FINGERS		
	Inspect the release bearing and pressure plate fingers for wear.	OK	ROAD TEST.
		Bearing Rough/Noisy Pressure Plate Fingers Worn	REPLACE bearing; REPLACE pressure plate if release fingers are more than 1.52mm (0.060 inch) out-of-plane as installed on flywheel. CHECK flywheel housing bore and face alignment, then ROAD TEST.
5.0	PILOT BEARING		
	Inspect pilot bearing for proper installation, wear and loss of lubrication.	OK	ROAD TEST.
		Bearing Worn	REPLACE as required.

NOTE: A light intermittent clicking noise may result during pedal application. Some noise under these situations will not adversely affect clutch function and does not ncessarily indicate a failed release bearing or out-of-plane pressure plate release fingers. Inspection of these components is not required unless the noise is excessive.

CC4561-2B

Testing Procedures

Squeak or Scrubby Noise Test

1. Work the clutch pedal back and forth.
2. Note any binding condition or lack of lubrication in the linkage. To help pinpoint noise it may be necessary to disconnect and isolate some components.

Transmission Gear Rollover or Transmission Bearing Noise Test

1. Let engine idle, placing transmission shift selector in neutral position.
2. Depress clutch pedal.

With the clutch pedal fully depressed, the transmission input shaft will stop rotating. If the input shaft bearing or transmission gears were causing a noise, the noise should stop.

If noise is still present, perform Clutch Release Bearing (Rotational Underload) Noise Test.

Clutch Release Bearing (Rotational Underload) Noise Test

NOTE: A light intermittent clicking or rattling noise may result during pedal application due to the clutch solenoid lockout switch and cruise control clicking. Some noise under these conditions will not adversely affect clutch function and does not necessarily indicate a failed release bearing or out of plane pressure plate

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release fingers. Inspection of these components is not required unless the noise is excessive.

1. Let the engine idle with the transmission shift selector in neutral position.
2. Depress clutch pedal.
3. Listen for any change in noise level.

If the release bearing is the cause of the noise; the noise should stop with pedal depressed. Replace the release bearing.

Bearing Travel Measurement

F-Series with 7.3L Diesel and 7.5L Gasoline Engines

1. With the clutch pedal depressed fully to the floor measure the external slave cylinder push rod travel.
2. The push rod should extend 13.5mm (0.53 inch) minimum. Do not replace the clutch hydraulic system if the measurement exceeds this distance.

NOTE: If the slave cylinder travel does not meet the travel requirements, check the hydraulic reservoir fluid level.

F-Series and Bronco with 4.9L, 5.0L, and 5.8L Gasoline Engines

1. Remove the rubber plug from the inspection port in the side (Mazda) or bottom (Z-F) of the transmission bell housing.
2. Position Tool D87T-4201-A, or equivalent through the opening and against the slave cylinder as shown.
3. Using the rear edge of the black plastic bearing retainer as an indicator, take a reading with the clutch pedal fully up.
4. Have an assistant fully depress the pedal and take another measurement.
5. The difference between the two readings is the total bearing travel.
6. If the bearing travel is less than 10.8mm (0.425 inch), check the hydraulic reservoir fluid level, then inspect the hydraulic system for leaks. Fill the reservoir if required. If a leak is located in the system, replace the worn or damaged component and bleed the system. If no leak is found, bleed the system. Recheck the bearing travel after repairs have been completed.

Clutch Squeal Test

A clutch noise sometimes referred to as a "squeal" may be evident as the clutch pedal is held down.

1. Let engine idle, placing transmission shift selector in neutral position.
2. Depress to floor and SLOWLY release clutch pedal.

If the noise is reduced or eliminated as the clutch pedal is released and the input shaft begins to turn, the pilot bearing could be the possible cause.

Replace pilot bearing. Refer to flywheel housing alignment, and inspection and alignment procedure in this Section.

Clutch Chatter and Slippage Test

A clutch or vehicle vibration called "chatter" is evident just as the clutch is released and the vehicle starts to move.

Contamination of the clutch disc friction surfaces, causing uneven friction, may make the power transfer uneven and result in a "chatter."

Oil leakage or grease on the clutch disc is the major cause of chatter.

Loose, misaligned or broken engine mounting(s) can cause clutch chatter.

Overheated clutch from excessive slippage or abuse can cause chatter.

Clutch slippage may have several causes (oil leakage on clutch disc, operator abuse, excessively worn disc).

ADJUSTMENTS

Flywheel Housing Alignment (Warner Transmission)

Inspection and/or alignment of the flywheel housing is indicated when symptoms exist of excessive transmission gear wear, transmission jumping out of gear, driveline vibration, clutch pedal vibration or scrubby feel, pilot bearing noise, release bearing noise, or excessive clutch spin time. Common complaint area or obvious misadjustment should always be checked and corrected prior to checking alignment, to be sure the basic system is in working order.

Inspection and Alignment Procedure (Warner Transmission)

1. Remove the transmission and flywheel housing from the vehicle as outlines in the appropriate transmission Section in Group 16.
2. Inspect, clean and/or remove all nicks, burrs, paint and all other foreign material from the following:
   a. Front and rear face of flywheel housing.
   b. Flywheel housing bore surface.
   c. Rear face of engine block.
   d. Rear engine plate.
   e. Flywheel housing and engine block dowels (missing or damaged dowels must be replaced).
3. Install the flywheel housing and rear engine plate to the engine less the transmission and tighten the mounting bolts to specification. Refer to the appropriate transmission Section in Group 16.
4. Install Clutch Housing Alignment Tool T75L-6392-A or equivalent, with dial indicator base post attached (Fig. 3) through the flywheel housing bore into the clutch disc. Tighten the nut on the end of the post assembly until the clamp (split collet) on the opposite end of the assembly grips the clutch disc splined hub tightly (Fig. 4). Up, down, or side movement of the post assembly must not be evident during the bore and runout test procedure. If any movement is detectable, the nut should be further tightened until movement is stopped, otherwise erratic readings will result. To facilitate installation of the collet to the clutch disc hub, place a short piece of masking tape halfway around the collet to hold it at is smallest diameter until it can be inserted and tightened (Fig. 3).

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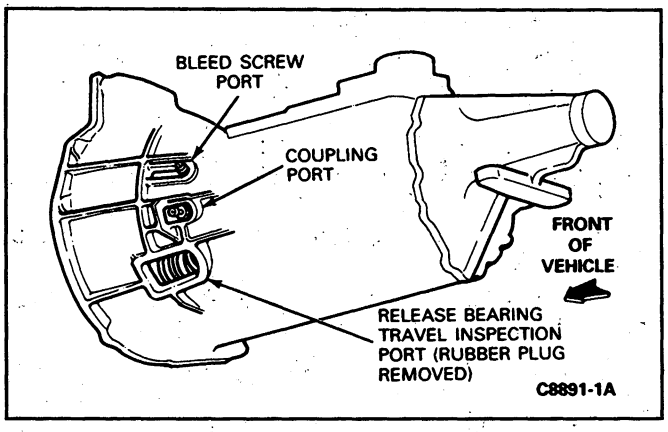


FIG. 1 Inspection Plug Removal

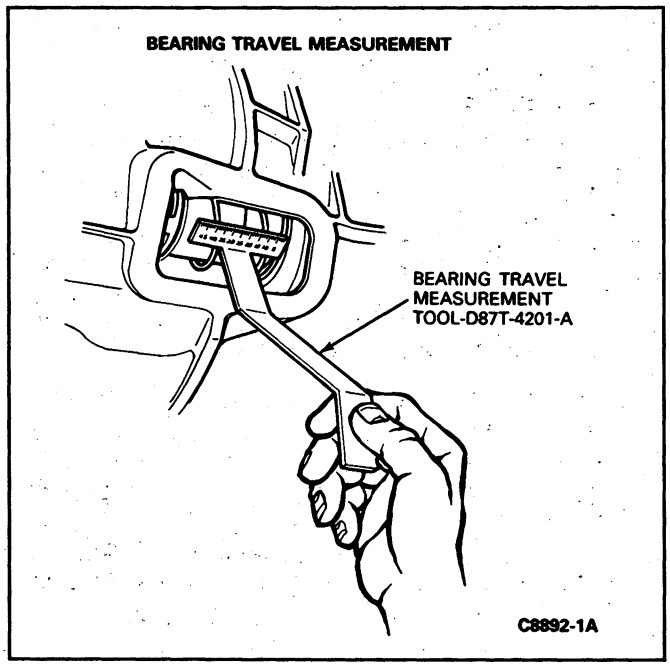


FIG. 2 Measuring Release Bearing Travel

5. To check face runout, install a dial indicator, TOOL-4201-C, on the base post using the universal bracket and short support bar (Tool T75L-4201-B) provided with the alignment kit (Fig. 3). Position the dial indicator so that the indicator button contacts a circumference just outside the transmission pilot hole. Tighten the universal clamp securely (Fig. 5).
6. Push the crankshaft rearward to remove any end play. Set the dial indicator to zero.
7. Holding the crankshaft in the rearward position, rotate the crankshaft through one complete revolution by using a wrench on the crankshaft pulley attaching nut. (Removal of spark plugs will relieve compression and ease crankshaft rotation). The dial indicator should return to zero after one revolution unless end play or a loose alignment post has affected the reading.
8. During Step 7, the greatest variation between indicator readings for one revolution should be recorded. A small mirror will be necessary during this procedure for viewing the dial indicator through its complete rotation.

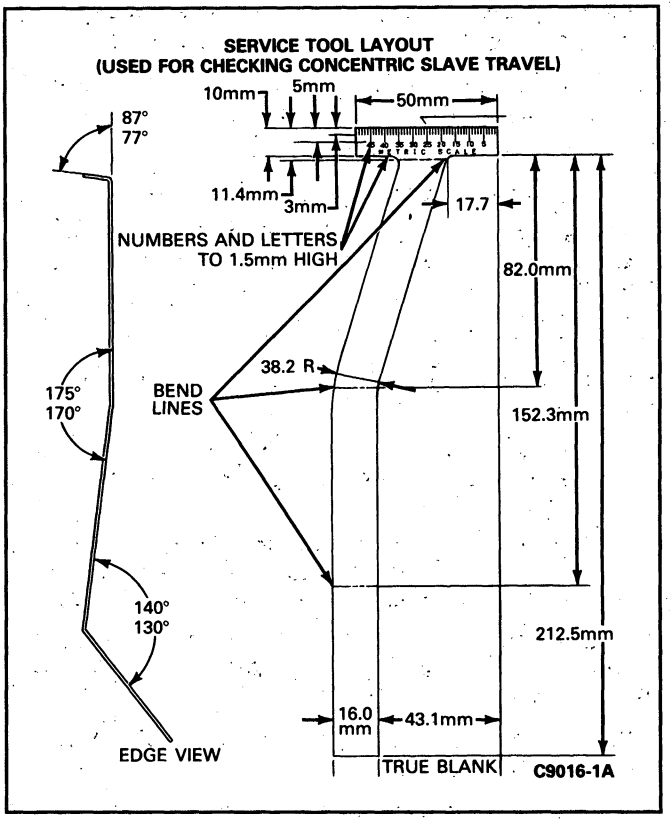


FIG. 3 Tool Fabrication

9. To verify the reading in Step 8, the procedure should be repeated a second time.
10. After completion of the face runout check, install the dial indicator lever attachment to the dial indicator (Fig. 3) and position the assembly to check bore runout (Fig. 6). The rubber band shown attached to the lever (Fig. 6) must be installed as indicated, prior to installation of the lever, to preload the dial indicator for bore readings.

    NOTE: The rubber band should be installed just snug enough to provide a light pressure of the lever tip on the bore of the housing. If the rubber band is too tight, it may bind the dial indicator or distort the reading.
11. Zero the dial indicator and rotate the crankshaft through one revolution as in Step 7. Record the greatest variation between the indicator readings for the complete crankshaft revolution. The reading should be verified by repeating the procedure a second time.
12. If the maximum variation measurements obtained in Steps 8 and 11 show that face runout exceeds 0.254mm (0.010 inch) and/or bore runout exceeds 0.381mm (0.015 inch), refer to 'Correction' below.

Before re-assembly of the transmission to the flywheel housing, the front mounting face of the transmission should be inspected and cleaned. Any nicks, burrs, paint or foreign material must be removed to be sure of alignment between the components. Transmission Welsh plugs should also be checked for proper installation. If the dowels on the flywheel housing or rear face of the engine are missing or damaged, refer to dowel removal and installation in this Section for instructions.

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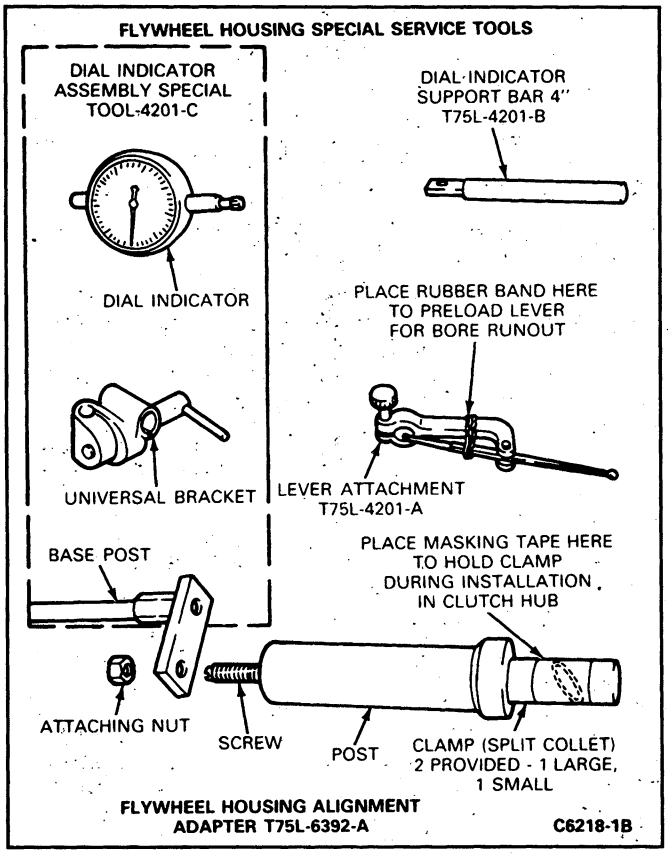


FIG. 4 Special Tools—Flywheel Housing Inspection and Alignment

Dowel Replacement Procedure

Use a drift pin on through holes and vice grip pliers or a similar tool on blind holes to remove dowels.

NOTE: Dowels should be pulled or driven from their seat using care not to damage the surface area around the dowel.

All solid type dowels can be installed by driving them into place using a brass or plastic mallet.

NOTE: Care should be exercised to drive the dowel squarely into place until fully seated and not to damage the surrounding surface area.

Alignment Correction (Warner Transmission)

Since any change in face alignment will change bore alignment, it may be possible to correct bore alignment by changing the face alignment. Face alignment can be changed by shimming between the flywheel housing and engine. Fig. 7 shows the type of shim which can be fabricated.

The shim required is one half the maximum (minus) indicator reading and should be located at the point of maximum (minus) indicator reading.

If both the bore and face alignment are out of limits, shim between the flywheel housing and engine to bring the face alignment within limits. Check the bore alignment.

If the bore alignment is out of limits and face alignment is within limits, shim the flywheel housing to the limit of face misalignment and check the bore alignment. If it is still not within limits, replace the housing.

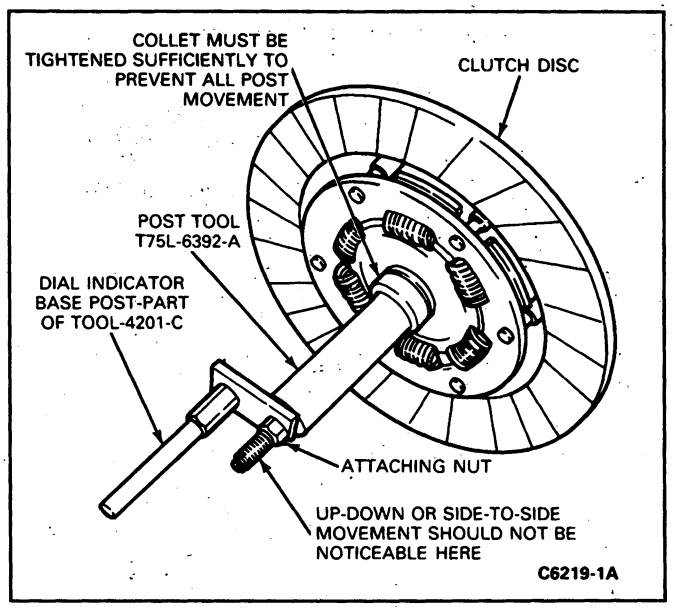


FIG. 5 Installation of Post Assembly

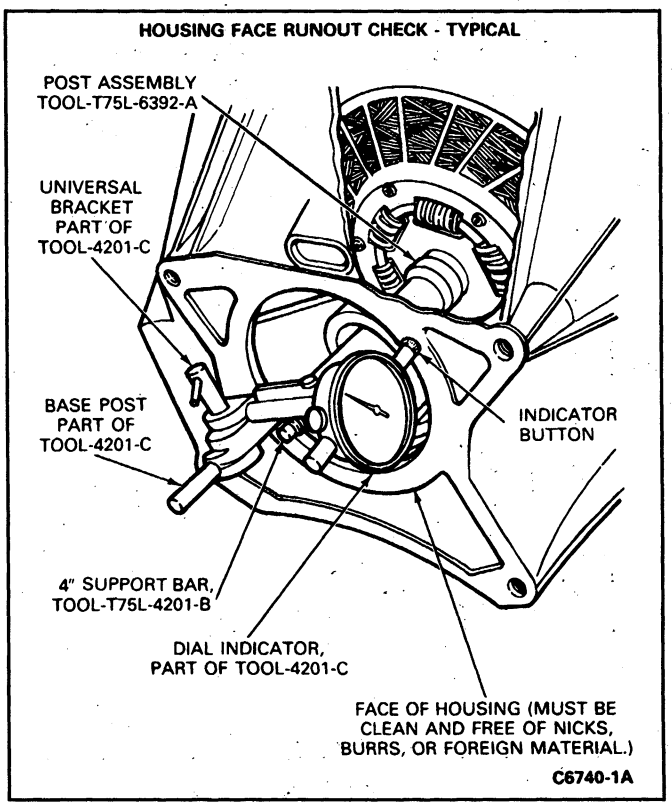


FIG. 6 Installing Dial Indicator For Face Runout Check

CLEANING AND INSPECTION

Clutch Release Bearing

Wipe all oil and dirt off the release bearing. The bearing is prelubricated and should not be cleaned with solvent. On all vehicles, the clutch release bearing and hub are serviced as a single unit. Do not disassemble them for inspection or replacement.

Inspect the release bearing as follows:

1. Hold the bearing, hub and back plate and rotate the outer race while applying a compressive

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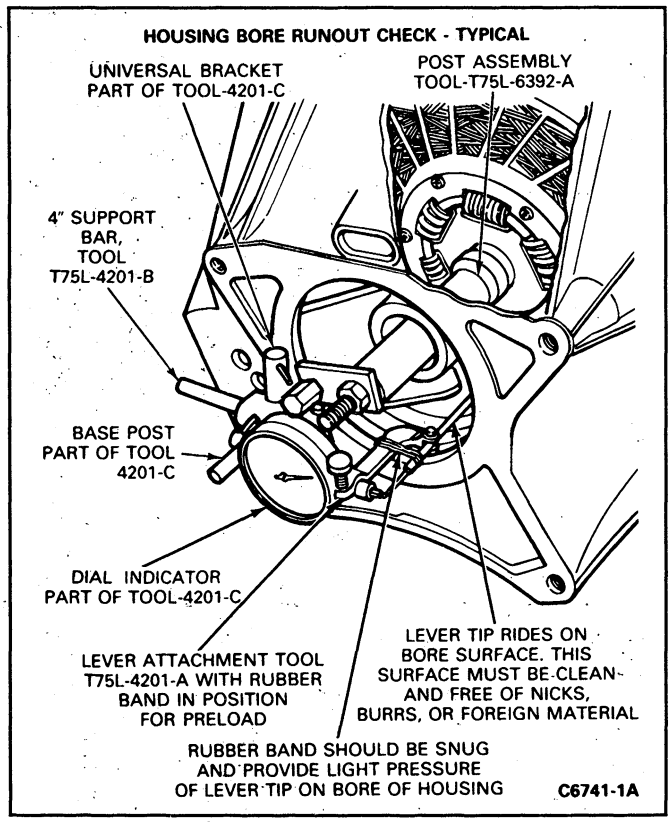


FIG. 7 Installing Dial Indicator For Bore Runout Check

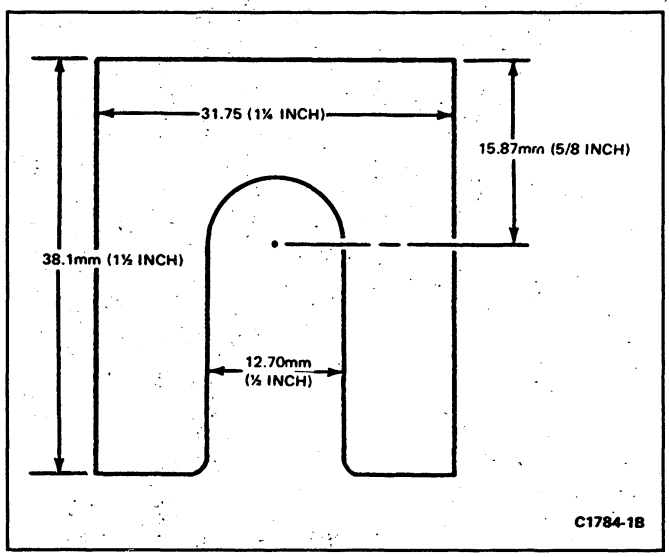


FIG. 8 Fabricated Flywheel Housing Shim

pressure. If the bearing rotation is rough, replace the bearing.

2. Inspect/remove any surface scoring or burrs that may impede the sliding motion of the release bearing on the transmission input shaft retainer. Any scoring or burrs should be polished off with a fine grade emery paper.

Prior to re-installation, lubricate for release bearing operation with lithium base grease, Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent, at the following points:

1. Fill annular groove of release bearing.
2. Thin coat on inside diameter of release bearing.
3. Fingers of clutch release lever (7.3L diesel and 7.5L gas engines only).
4. Fulcrum point of clutch release lever (7.3L diesel and 7.5L gas engines only).

Failure situations for release bearing operation:

1. Misalignment of clutch release lever (7.3L diesel and 7.5L gas engines only).
2. Misalignment between engine and the transmission. This condition will exhibit symptoms as transmission jumping out of gear, driveshaft vibration, excessive spin time resulting in gear clash, and clutch chatter on start-up.

NOTE: Also see Section 16-04, Hydraulic Clutch System for information on concentric slave cylinders.

Pressure Plate and Cover

The Belleville design pressure plate assemblies do not need to be lubricated.

Inspect the surface of the pressure plate for burn marks, scores, flatness or ridges. If the pressure plate is badly heat-checked or deeply scored, replace the pressure plate and cover assembly. Clean the pressure plate and flywheel surfaces with a suitable commercial alcohol base solvent to be sure that surfaces are free from any oil film. **Do not use cleaners with a petroleum base, and do not immerse the pressure plate in the solvent.**

If a substantial difference in finger wear exists, the heavily worn finger is binding. Replace the pressure plate.

Clutch Disc

Inspect the clutch disc facings for oil or grease. **Eliminate the source of any oil or grease before replacing the disc.** An excessive amount of grease on the bearing hub will find its way to the disc facings. Too much lubricant in the transmission or a plugged transmission vent will force the transmission lubricant out the input shaft and onto the disc facings. Leaking rear engine seals or loose or unsealed flywheel housing attaching bolts will allow engine oil to flow onto the disc facings.

Inspect the clutch disc for worn or loose facings. Check the disc for warpage and for loose rivets at the hub. Check for broken springs. **Springs loose enough to rattle will not cause noise when the vehicle is operating.**

Replace the disc if any of these conditions are present. When installing a new disc, be careful upon handling as not to drop it or contaminate it with oil or grease.

Flywheel Runout

Crankshaft End Play Check

1. Mount the dial indicator base on the rear of the engine with the indicator tip resting on the flywheel toward the outer edge.
2. Using a suitable pry bar, shift the engine crankshaft forward and rearward while taking an indicator reading. Compare reading with specifications found in the Light Truck Engine Shop Manual.

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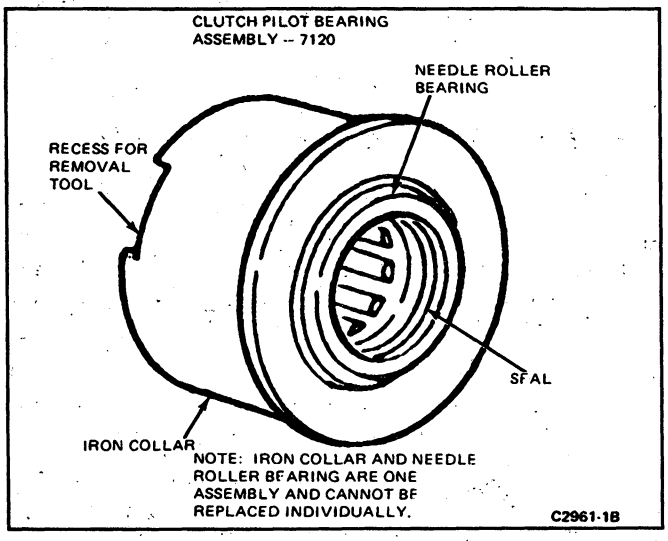


FIG. 9 Pilot Bearing (Needle Roller Type)

Flywheel Face Runout

Refer to Section 16-10, General Manual Transmission Service for flywheel face runout checks.

Pilot Bearing Assembly

Refer to Fig. 8.

Check the fit of the clutch pilot bearing in the bore of the crankshaft. The bearing is pressed into the crankshaft and should not be loose.

Check the pilot bearing (needle type) assembly for mis-alignment and press fit condition in the crankshaft. Visibly inspect the bearing surfaces (needle rollers and transmission input shaft) for scoring, worn or broken rollers, inadequate grease and discoloration due to heating. Check the condition of the bearing's seal. There should be no visible grease leakage on the bearing retainer or the crankshaft. Refer to Section 16-02, Clutch, for replacement.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lbs.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T57L-500-B	Bench-Mounted Holding Fixture	Universal
T75L-4201-A	Clutch Housing Alignment Adapter	Universal — Use with Dial Indicator for Right Angle Measurements
T75L-4201-B	Clutch Housing Alignment Adapter	Universal
D87T-4201-A	Release Bearing Travel Measurement Tool	Universal
D78P-4201-B	Dial Indicator with Magnetic Base	Universal
TOOL-4201-C	Dial Indicator with Bracketry	Universal
T75L-6392-A	Clutch Housing Alignment Tool	Universal — Use with Clutch Housing Alignment Adapter and Dial Indicator
D79T-7550-A	Clutch Alignment Shaft	10 Spline — 1-1/2 Inch Outside Diameter
D79T-7550-B	Clutch Alignment Shaft	10 Spline — 1-3/4 Inch Outside Diameter
D79T-7550-C	Clutch Alignment Shaft	10 Spline — 2 Inch Outside Diameter

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SECTION 16-02 Clutch

SUBJECT	PAGE
DESCRIPTION AND OPERATION	16-02-1
DIAGNOSIS AND TESTING	16-02-1
REMOVAL AND INSTALLATION	
Clutch Pilot Bearing	16-02-1
Clutch Release Lever—7.3L Diesel and 7.5L Gas Engines Only	16-02-1
REMOVAL AND INSTALLATION (Cont'd)	
Single-Disc-Type Clutch	16-02-2
SPECIFICATIONS	16-02-4
VEHICLE APPLICATION	16-02-1

VEHICLE APPLICATION

All E-150, F-150—F-350, F-Super Duty Chassis Cab, Stripped Chassis and Bronco Vehicles Equipped with Manual Transmission.

DESCRIPTION AND OPERATION

The purpose of the clutch is to connect and disconnect a manually operated transmission and the remainder of the power-transmission system from the engine. This permits starting and stopping the vehicle, shifting and changing speeds that correspond to the engine speed through gear reductions for both forward and reverse directions.

The clutch consists of a driven plate (clutch disc) splined for the input shaft of the transmission and the clutch housing (pressure plate).

This forms a continuous system by which rotation of the engine is connected to the transmission by solid member when engaged (clutch assembly). For power at the output shaft of the transmission or rear wheel rotation (forward or reverse), the driven plate is a metal disc, faced on both sides with woven friction materials. The pressure plate is a metal member bolted on the flywheel which houses the driven plate held in position by the transmission input shaft. A clutch sleeve mounted over the input shaft of the transmission carries a release bearing that is pressed against the fingers of the clutch that pushes it away from the driven plate causing disengagement—breaking the connection between the engine (flywheel) and the clutch. Reverse action or the release of the bearing engages the clutch. The release lever is actuated by a hydraulic system (refer to Section 16-04, Hydraulic Clutch System).

Other internal clutch parts are a pilot bearing mounted in the crankshaft which supports the end of the input shaft. Bearings are designed for long life and require no lubrication.

DIAGNOSIS AND TESTING

Refer to Section 16-01, General Clutch Service.

REMOVAL AND INSTALLATION

Clutch Pilot Bearing

A needle roller bearing and collar assembly is used as a clutch pilot bearing on all vehicles (Fig. 1). It is inserted directly into the engine crankshaft. The bearing and collar assembly is a one piece unit that cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pregreased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

Removal

1. Remove the transmission, clutch pressure plate, and disc following the procedures in Group 16.
2. Using Impact Slide Hammer Puller, T58L-101-B (or equivalent) remove the pilot bearing (Fig. 2).

Installation

1. Using Pilot Bearing Replacer T74P-7137-A and Clutch Aligner T71P-7137-H or equivalent, install the pilot bearing with the seal facing the transmission (Fig. 3) so that the adaptor is not cocked.
2. Install the clutch pressure plate, disc, and transmission following the procedure in this Section and the appropriate transmission section in Group 16.

NOTE: Care must be taken not to damage the bearing during transmission installation while the transmission input shaft is being inserted into the bearing.

Clutch Release Lever—7.3L Diesel and 7.5L Gas Engines Only

Refer to Fig. 5.

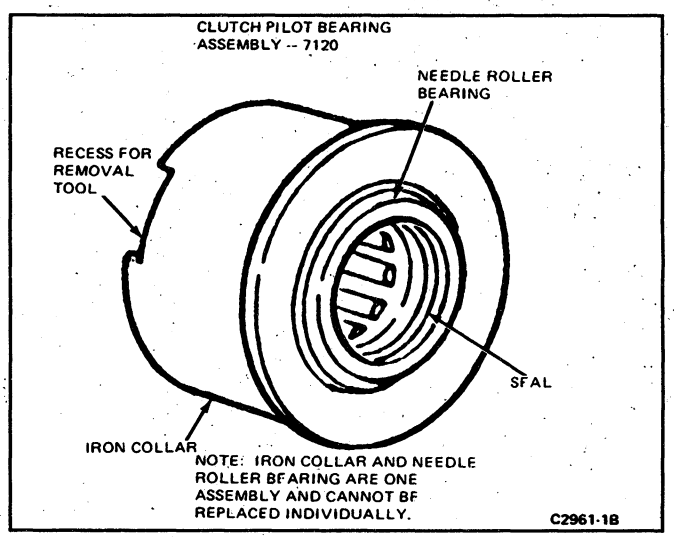


FIG. 1 Pilot Bearing Assembly (Needle Roller Type)

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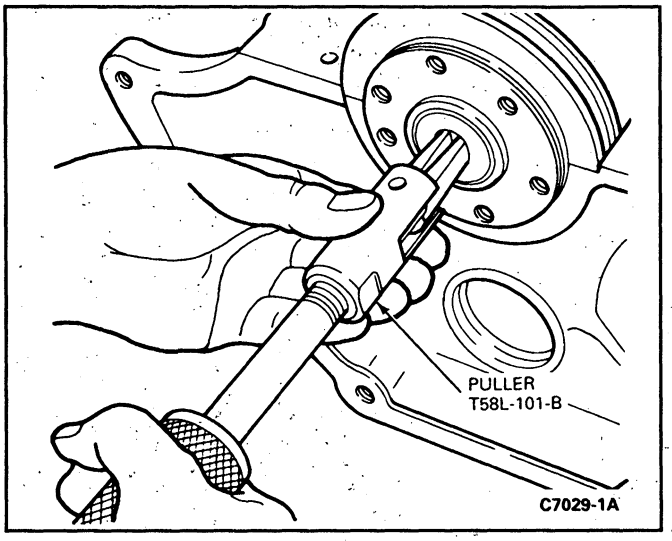


FIG. 2 Removing Clutch Pilot Bearing Assembly

Removal

1. Raise the vehicle and install safety stands.
2. Remove the dust boot from the opening in the clutch bell housing.
3. Push the release lever forward to compress the slave cylinder.
4. On 7.3L diesel and 7.5L gas engines, the steel retainer clip is permanently attached to the slave cylinder. Remove the slave cylinder by prying on the clip to disengage the tangs while pulling the slave cylinder free of the bracket.
5. Remove the release lever by pulling the lever outward.

Installation

1. Install the release lever on the release bearing hub and the pivot stubs, making sure it is properly positioned. Push the lever inward until it snaps onto the studs.
2. Install the slave cylinder and attaching clip.
3. Install the dust shield in the opening in the bell housing.
4. Lower the vehicle. Depress the clutch pedal ten times to refill the slave cylinder and seat the components. Check the clutch system for proper operation.

Single-Disc-Type Clutch

Standard Disc and Pressure Plate Assembly— 10.0 Inch/11.0 Inch/12.0 Inch

Removal

1. Disconnect the battery negative cable.
2. Remove clutch slave cylinder, or the hydraulic line quick disconnect using quick disconnect Tool T88T-70522-A.
3. Remove the release lever if so equipped.
4. Remove the dust cover if so equipped.
5. Refer to the appropriate transmission Section of this Manual for instructions and remove the transmission from the vehicle.

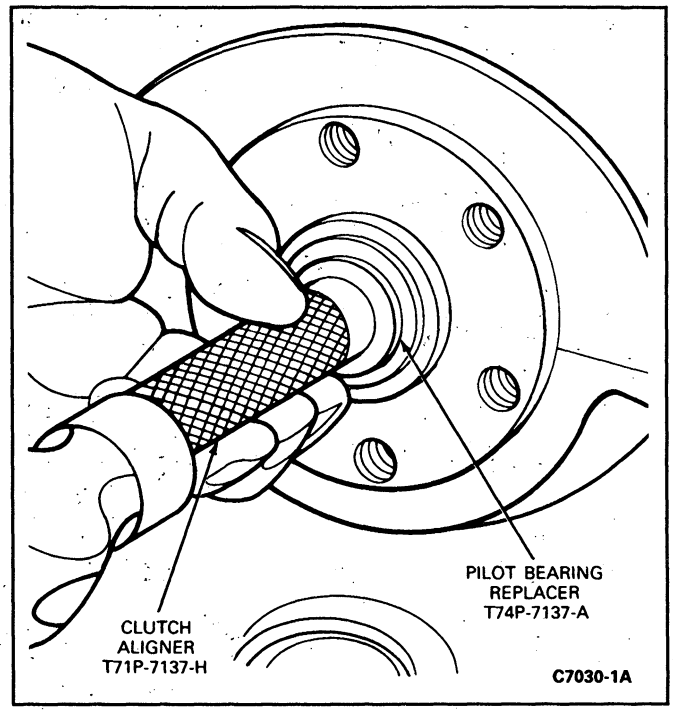


FIG. 3 Installing Clutch Pilot Bearing Assembly

6. Mark the assembled position of the pressure plate and cover to the flywheel (for re-assembly).
7. Remove the pressure plate and cover assembly and the clutch disc from the flywheel. **Remove the pilot bearing only for replacement.**

Installation

CAUTION: The new 7.3L cover assembly bolt is 5/16 in. x 18 x .75 in. while the 7.5L EFI cover bolt is 5/16 in. x 18 x .92 in.. The .92 inch-long bolt CANNOT be used with the dual mass flywheel because it will extend beyond the inner surface of the secondary flywheel and interfere with the primary flywheel. Only the new .75 in. cover bolt can be used with the dual mass flywheel.

1. Position the clutch disc on the flywheel so that the Clutch Alignment Shaft D79T-7550-A or equivalent can enter the clutch pilot bearing and align the disc.
2. When re-installing the original pressure plate and cover assembly, align the assembly and flywheel according to the marks made during the removal operations. Position the pressure plate and cover assembly on the flywheel, align the pressure plate and disc, and install the retaining bolts that fasten the assembly to the flywheel. Tighten the bolts to specification (refer to Figs. 4, 5 and 6) and remove the clutch disc pilot tool.
3. On 7.3L diesel and 7.5L gas engines, clean and lubricate the transmission bearing retainer. Clean the bearing hub bore and install on the retainer. Clean and lubricate the release lever pivot stud.
4. Reinstall the transmission.
5. Correctly position the release lever (if so equipped) in its release bearing hub, and align with the pivot stud. Push inward on the lever until it snaps into position.

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6. Reinstall the external slave cylinder, or attach the hydraulic tube quick connect fitting.
7. Install the dust boot if so equipped.
8. Install the starter motor.

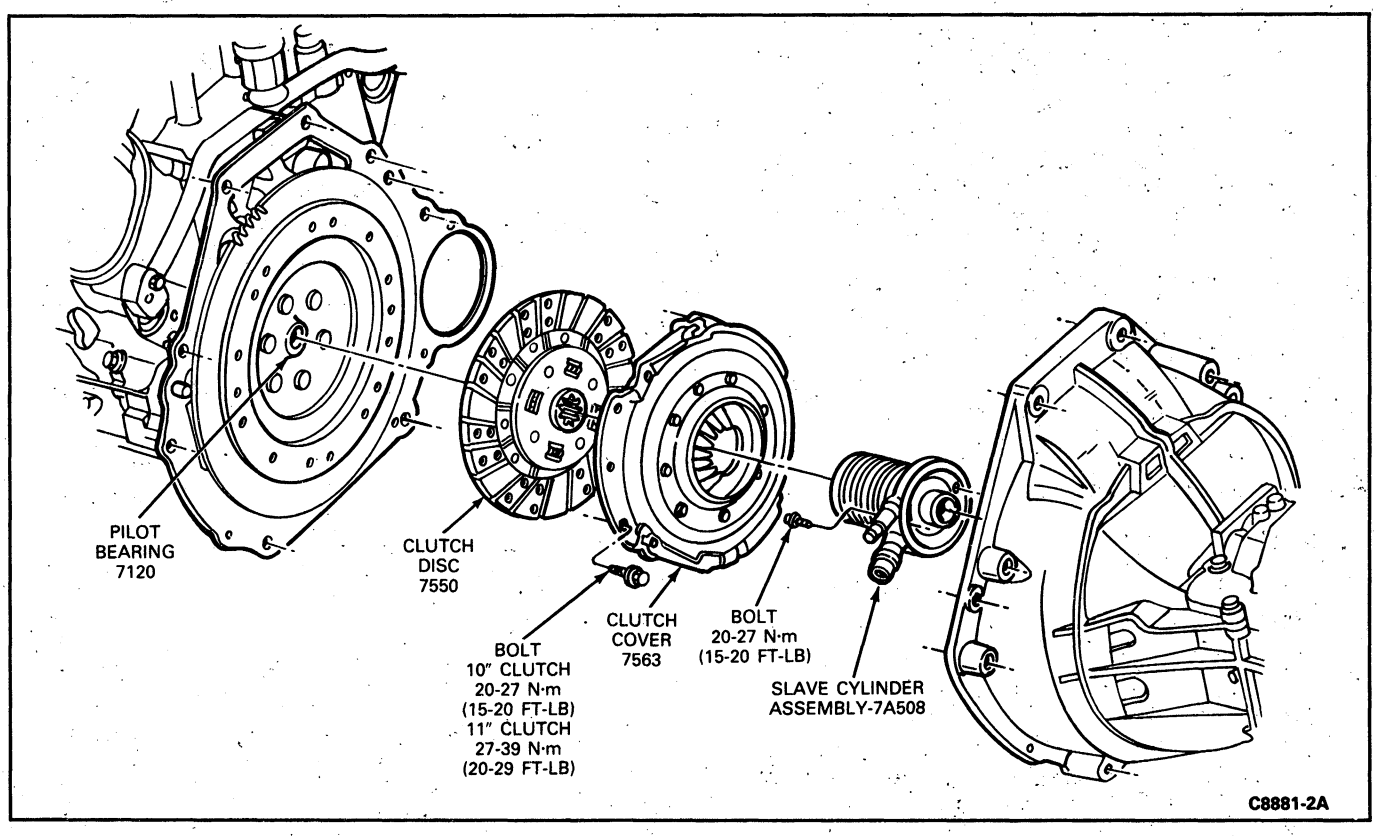


FIG. 4 Clutch Installation—E-150, F-150—F-250, Bronco with 4.9L, 5.0L and 5.8L Engines

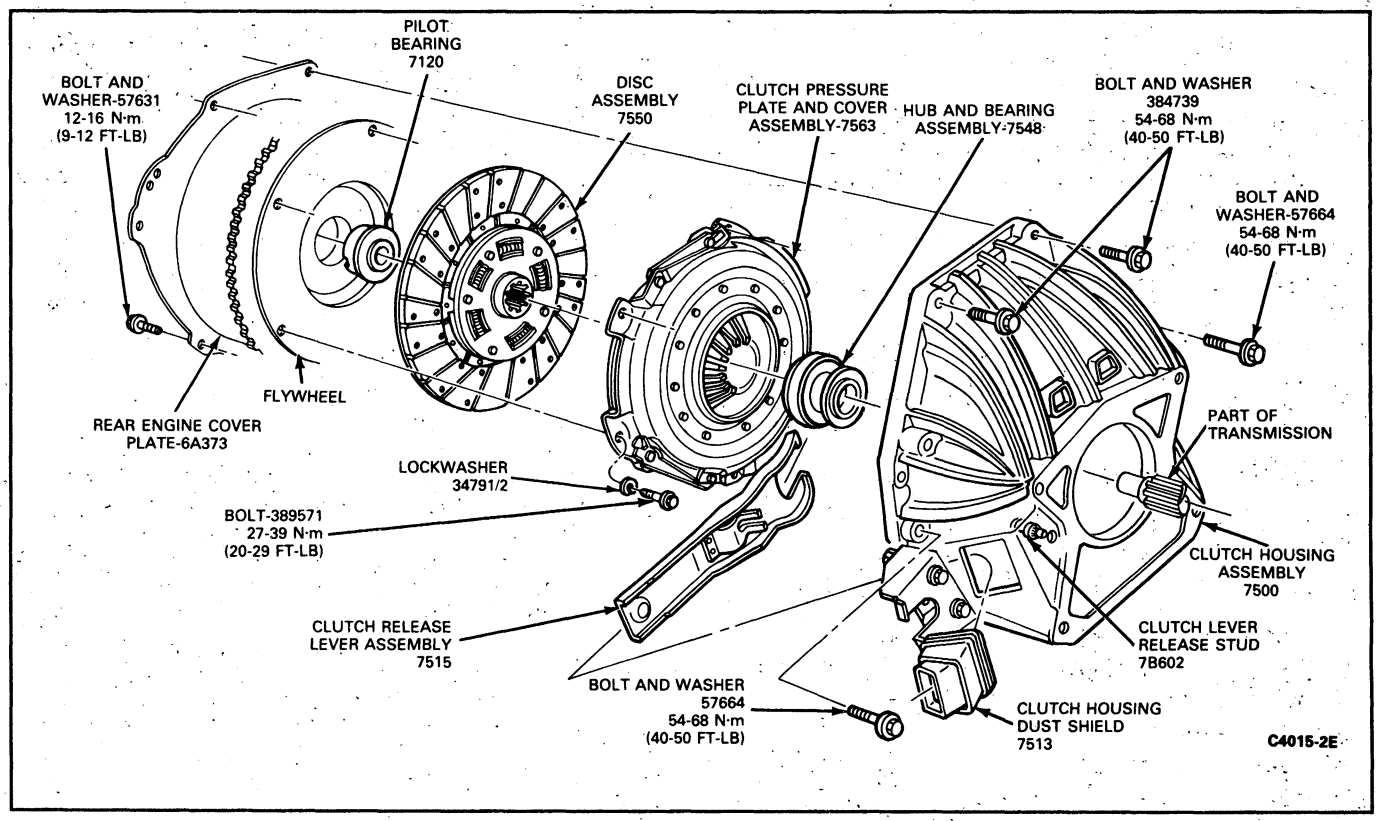


FIG. 5 Clutch Installation (Warner Transmission)—F-150—F-250 and Bronco with 4.9L (300 CID) and 5.0L W (302 Engine)

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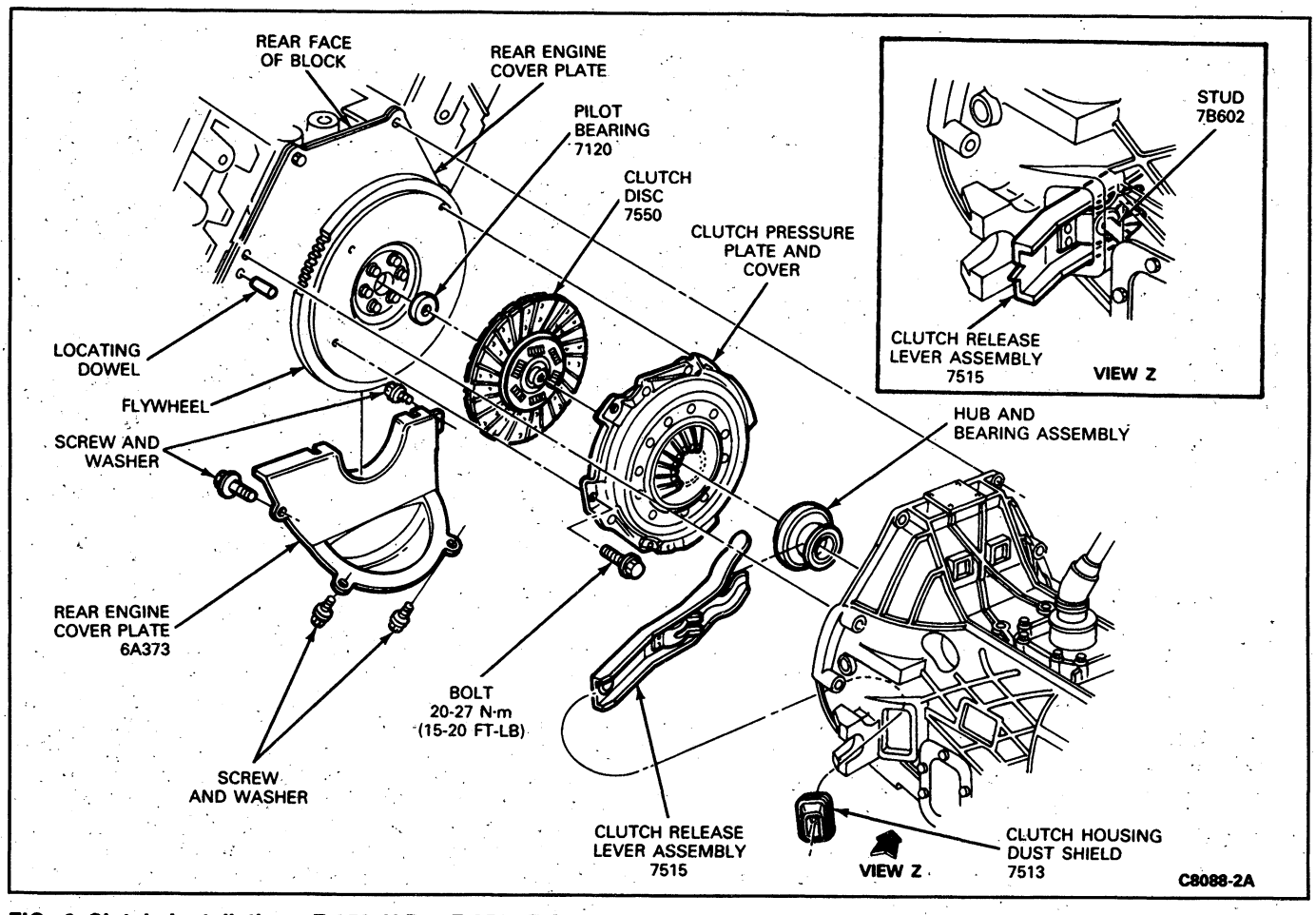


FIG. 6 Clutch Installation—F-250 H.D.—F-350, F-Super Duty Chassis Cab and Commercial Stripped Chassis with 7.3L Diesel Engine and 7.5L (460 CID) V-8 Engine

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lbs.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T57L-500-B	Bench Mounted Holding Fixture	Universal
T00L-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T75L-4201-A	Clutch Housing Alignment Adapter	Universal — For Right Angle Measurements
T75L-4201-B	Clutch Housing Alignment Adapter	Universal
D78P-4201-B	Dial Indicator with Base	Universal
T00L-4201-C	Dial Indicator with Bracketry	Universal
T75L-6392-A	Clutch Housing Alignment Tool	Use with Clutch Housing Alignment Adapters and Dial Indicator
D79L-7000-A	Retaining Ring Pliers	Universal
T74P-7137-A	Pilot Bearing Replacer	Use with Clutch Aligner
T71P-7137-H	Clutch Aligner	Universal
D79T-7550-A	Clutch Alignment Shaft	1-1/2 Inch Outside Diameter — 10 Spline
D79T-7550-B	Clutch Alignment Shaft	1-3/4 Inch Outside Diameter — 10 Spline
T88T-70522-A	Clutch Line Disconnect Tool	Quick Disconnect Clutch Lines

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SECTION 16-04 Hydraulic Clutch System

SUBJECT	PAGE
ADJUSTMENTS	
Clutch/Starter Interlock Switch Adjustment—Econoline Only	16-04-2
Hydraulic Clutch—Master Cylinder Pushrod Length Adjustment	16-04-2
DESCRIPTION AND OPERATION	
Clutch Interlock Three Function Switch—F-Series and Bronco	16-04-1
Clutch/Starter Interlock Switch—Econoline	16-04-1
DIAGNOSIS AND TESTING	
Clutch/Starter Interlock Switch	16-04-2
REMOVAL AND INSTALLATION	
Bleed Procedure for External Slave Cylinder	16-04-7
REMOVAL AND INSTALLATION (Cont'd)	
Bleeding Procedure—Concentric Slave Cylinder	16-04-6
Clutch Hydraulic System	16-04-4
Clutch Interlock Three Function Switch	16-04-8
Clutch Pedal	16-04-5
Clutch Release Bearing	16-04-8
Clutch Slave Cylinder	16-04-9
Cross-Shaft Lever	16-04-4
Hydraulic Clutch Line	16-04-8
SPECIFICATIONS	16-04-10
VEHICLE APPLICATION	16-04-1

VEHICLE APPLICATION

Applies to All E-150, F-150—F-350, F-Super Duty Chassis Cab, Commercial Stripped Chassis and Bronco Vehicles Equipped with Manual Transmission.

DESCRIPTION AND OPERATION

The hydraulic clutch control system consists of a combination clutch fluid reservoir and master cylinder assembly, a slave cylinder and connecting tubing (Figs. 1, 2 and 3).

The combination clutch reservoir and master cylinder is located inboard of the brake vacuum booster. Fluid level is checked at the reservoir. The master cylinder converts mechanical clutch pedal movement into hydraulic fluid movement.

The clutch external slave cylinder is mounted on the transmission bell housing, for all trucks equipped with the 7.3L diesel or 7.5L gas engines. All other vehicles use a concentric mounted slave cylinder in the transmission bell housing. The slave cylinder converts the hydraulic fluid movement to mechanical movement to activate the clutch release lever.

The hydraulic clutch system provides automatic clutch adjustment. No adjustment of clutch linkage or pedal position is required.

NOTE: As the clutch disc wears, the fluid level in the reservoir will rise. The fill line step in the reservoir is the normal level for a new system.

Clutch/Starter Interlock Switch—Econoline

All Econoline vehicles with manual transmissions are equipped with a starter/clutch interlock system which requires the clutch pedal to be depressed all the way to the floor in order to start the engine. The system operates by means of a switch located on the brake and clutch pedal support bracket (Fig. 4). The switch plunger is attached to the clutch pedal and extends as the clutch pedal is depressed to actuate the switch. The switch is electrically connected across the ignition switch and the starter motor relay coil to maintain an open starter circuit with the clutch engaged (pedal up) position. The switch is designed with a self-adjusting feature which provides for the switch to be set automatically with the first flooring of the clutch pedal. The self-adjusting feature consists of a two piece clip which is snapped together over a serrated plunger (rod). When the switch plunger or rod is extended, the clip bottoms out on the switch body and causes the rod to ratchet over the serrations to a position determined by the clutch pedal travel limit. The switch is now adjusted to close the starter circuit when the clutch pedal is floored.

NOTE: Care must be taken to prevent mis-adjustment of the switch by avoiding operation or changing the "as shipped" position of the self-adjusting clip on the plunger (rod).

Clutch Interlock Three Function Switch—F-Series and Bronco

Refer to Fig. 5.

All F-Series and Bronco Trucks with manual transmissions are equipped with a switch which is concentrically located on the master cylinder push rod. The switch has three functions:

- It requires the clutch pedal to be depressed to the floor in order to start the engine.
- It cuts off the speed control system when the clutch pedal is depressed.
- It provides a fuel control signal to the EEC system.

DIAGNOSIS AND TESTING

For diagnostic and testing procedures, other than those below, refer to Section 16-01, General Clutch Service.

If release bearing travel does not meet the travel requirements (see Release Bearing Travel Measurement in Section 16-01), check the reservoir fluid level (Figs. 1, 2 and 3). The slave cylinder must be in place when checking the fluid level. The proper level is indicated by a step on the reservoir. Fill to the specified level with Ford Heavy Duty Brake Fluid C6AZ-19542-AA or -BA (ESA-M6C25-A) or equivalent DOT 3 fluid. Do not overfill. The upper portion of the reservoir

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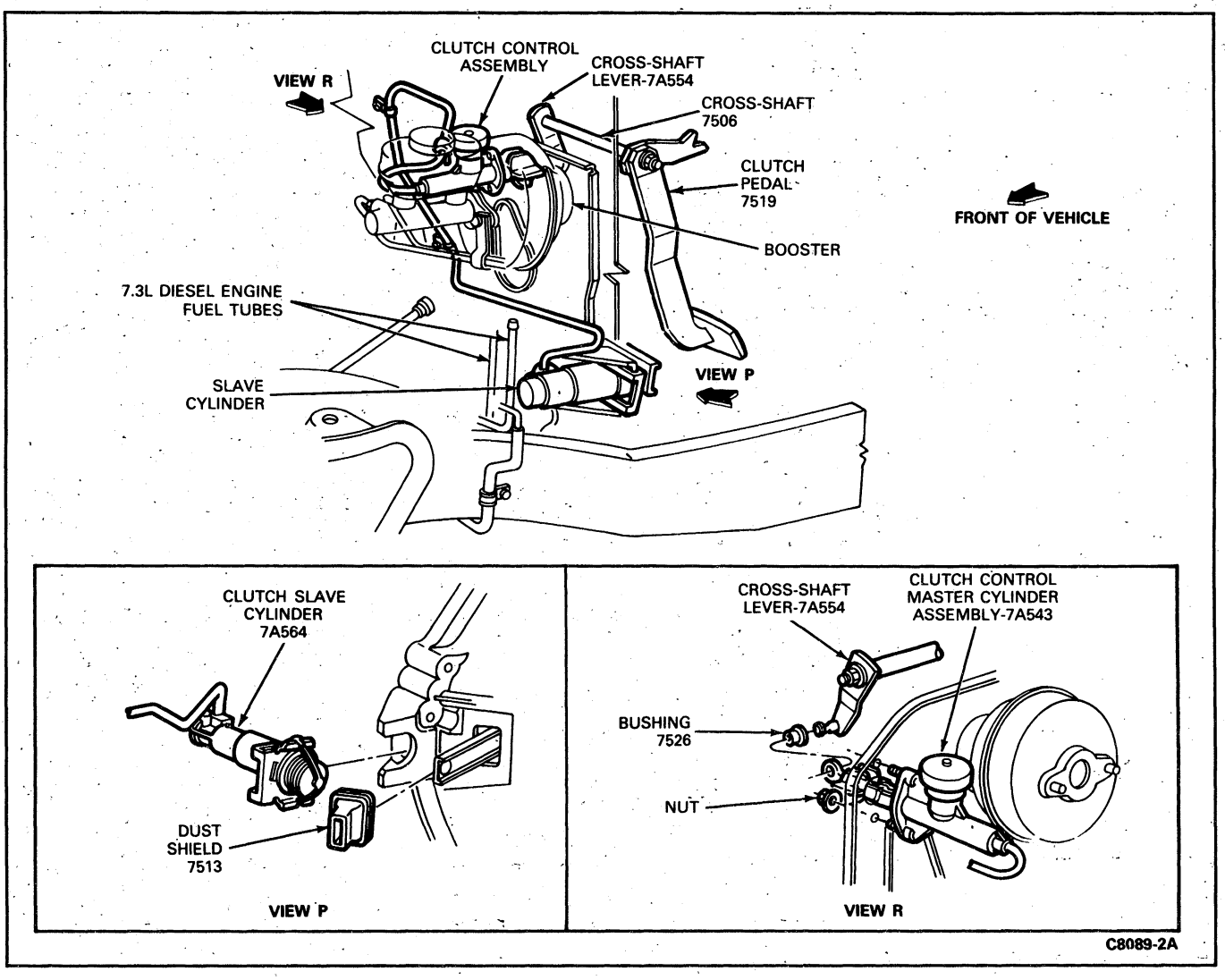


FIG. 1 Hydraulic Clutch System 7.3L Diesel Engine and 7.5L (460 CID) Gas Engine—Typical

must accept fluid that is displaced from the slave cylinder as the clutch wears.

CAUTION: Carefully clean the top and sides of the reservoir before opening to prevent contamination of the system with dirt, water and other foreign material. Remove the reservoir diaphragm when checking or adding fluid. Carefully replace the diaphragm, cover gasket and cover after filling.

If the reservoir requires any fluid, check the hydraulic system components for leakage. Remove the rubber boots from the cylinder and check for leakage past the pistons. A slight wetting of the surfaces is acceptable. If excessive leakage is evident, replace the leaking component.

Clutch/Starter Interlock Switch

For switch diagnosis and testing, refer to Section 37-01 Speed Control System.

ADJUSTMENTS

Clutch/Starter Interlock Switch Adjustment—Econoline Only

Refer to Fig. 4.

If the adjusting clip is out of position on the rod, remove both halves of the clip. Position both halves of the clip closer to the switch and snap the clips together on the rod. Depress the clutch pedal to the floor to adjust the switch.

Hydraulic Clutch—Master Cylinder Pushrod Length Adjustment

The proper position of Clutch Master Cylinder pushrod relative to the cross-shaft lever (7A554) pin is controlled by the procedure used when installing the cross-shaft lever.

To determine if the Clutch Master Cylinder pushrod and lever pin are in the correct relationship, disconnect the pushrod and note if it will reassemble to the pin. (When the pushrod is disconnected from the pin, the clutch Master Cylinder piston is fully retracted (rearward) and the clutch pedal blade is contacting the rubber bumper stop.)

If the two components are not in alignment, perform the following ONLY IN THIS SEQUENCE:

1. Tighten the clutch pedal attaching nut (L.H. side).
2. Reinstall the Clutch Master Cylinder pushrod to the cross-shaft lever pin.

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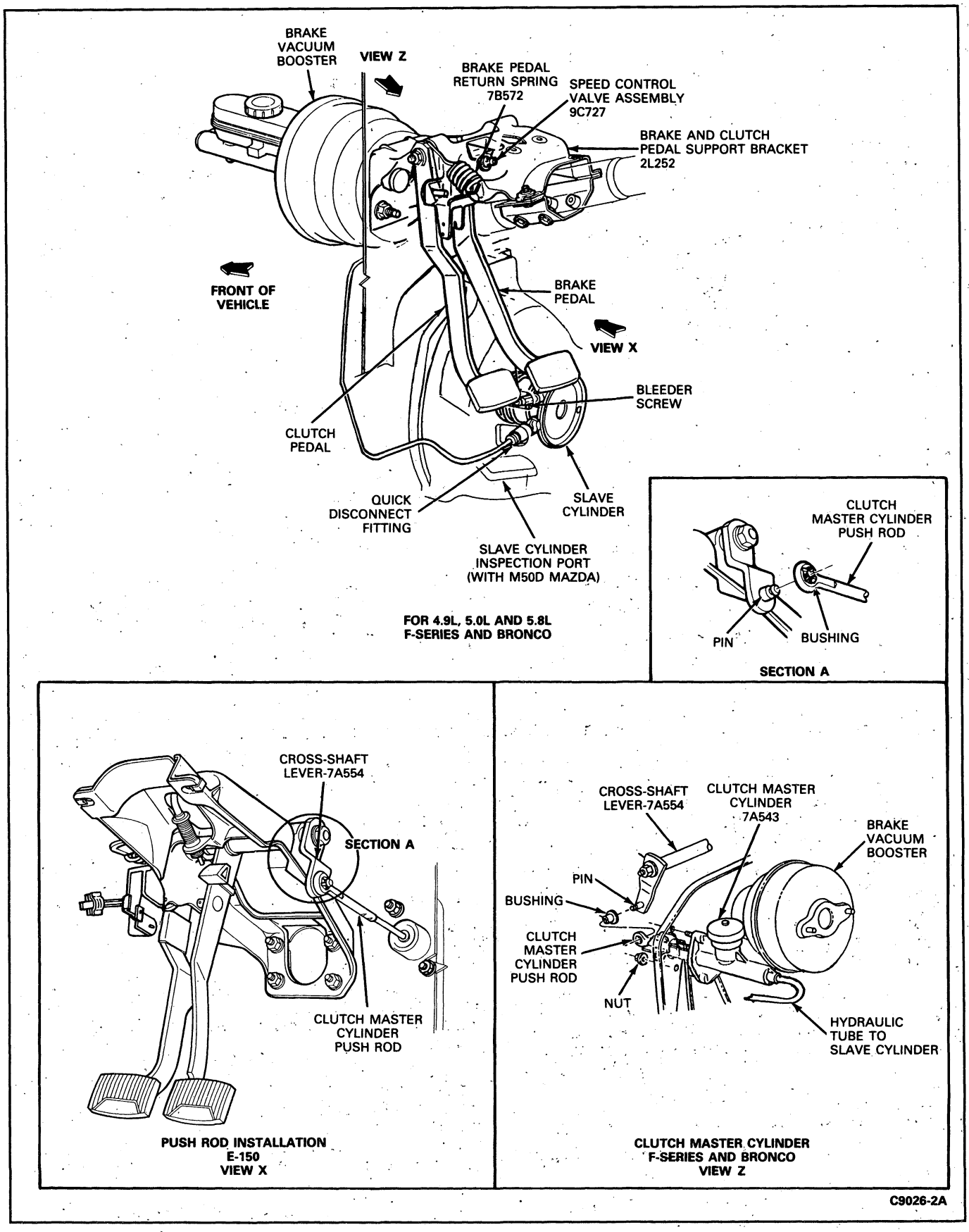


FIG. 2 Hydraulic Clutch System—4.9L, 5.0L and 5.8L Gas Engines—Typical

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3. Stroke the clutch pedal several times to reset the position of the shaft to the pedal slot. **This step is mandatory.**
4. Again, remove the Clutch Master Cylinder pushrod from the lever pin and evaluate the alignment. If the two components are still not in alignment, replace the cross-shaft lever. (If the pushrod is aligned with the pin, no further action is required.)

REMOVAL AND INSTALLATION

Cross-Shaft Lever

Removal

1. Disconnect the Master Cylinder pushrod from the cross-shaft lever pin (Fig. 5). (Use a small screw driver or putty knife to wedge between the lever and the snap-in bushing.)
2. Remove the attaching nut.
3. Pry the lever from the cross-shaft.

Installation

1. Snap the new lever (pin) to the Clutch Master Cylinder pushrod bushing.
2. Install the lever onto the cross-shaft.
3. Install the attaching nut, finger tight.
4. Inspect pedal position to insure that it is against the "up" stop.
5. Tighten the attaching nut. This will permit the knurled teeth on the shaft to cut matching teeth in lever, which then results in the correct positioning of the two components.

Clutch Hydraulic System

Refer to Figs. 1, 2 and 3.

NOTE: For vehicles equipped with external slave cylinders, prior to any vehicle service that requires removal of the slave cylinder, (i.e.; transmission removal), the master cylinder push rod must be disconnected from the clutch pedal. If not

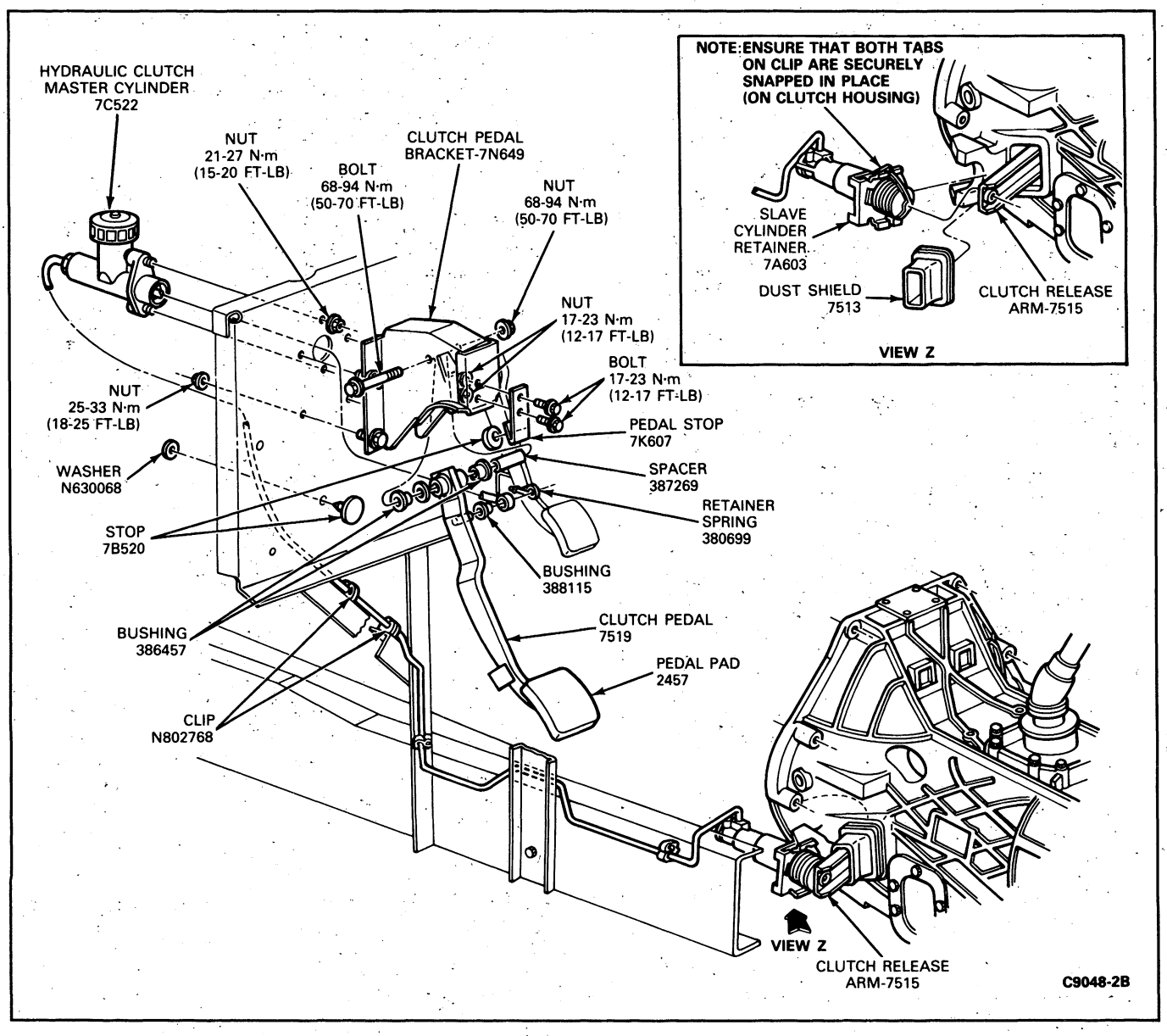


FIG. 3 Hydraulic Clutch System—F-Super Duty Commercial Stripped Chassis with 7.3L Diesel Engine

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disconnected, permanent damage to the slave cylinder will occur if the clutch pedal is depressed while the slave cylinder is disconnected.

Removal

1. From the inside of the cab, carefully pry the pushrod and retainer bushing from the cross-shaft lever pin.
2. Disconnect the interlock switch connector plug.
3. Remove the two nuts and support bracket retaining the clutch reservoir and master cylinder assembly to the firewall.
4. From the engine compartment, first note the clutch tube routing to the slave cylinder, then remove attaching hardware for the hydraulic tube retaining clips.

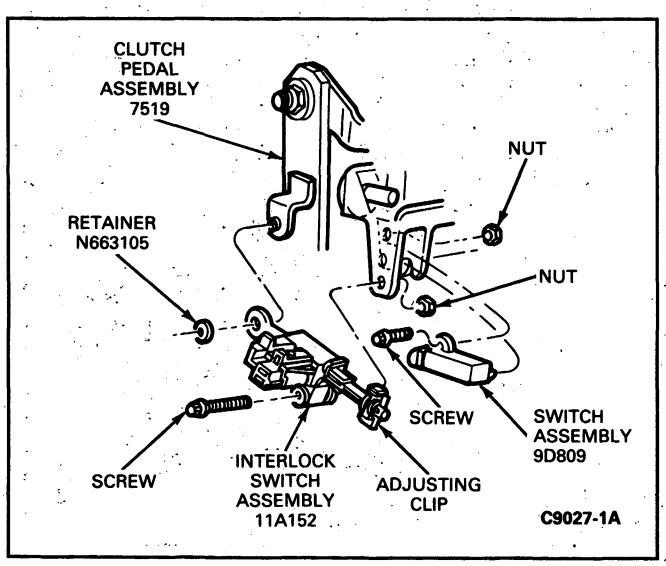


FIG. 4 Clutch/Starter Interlock Switch—Econoline

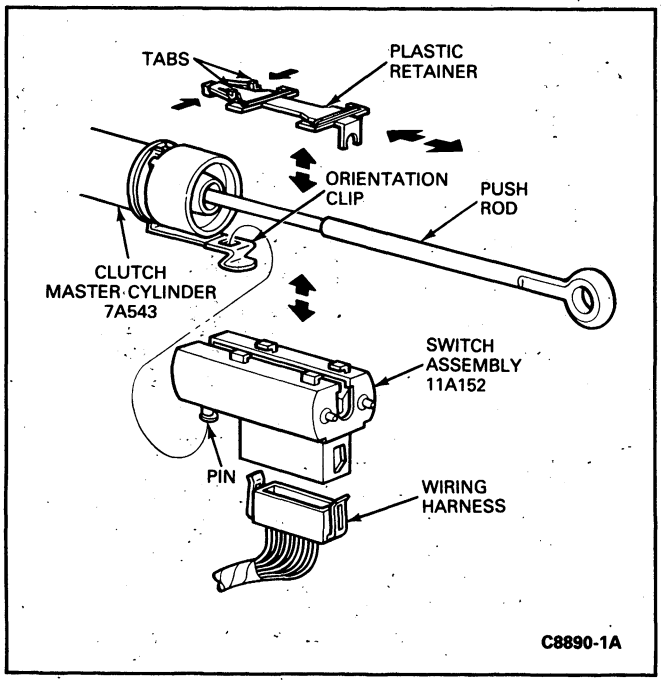


FIG. 5 Clutch/Starter Interlock Switch—F-Series and Bronco

5. From the engine compartment, remove the clutch reservoir and master cylinder assembly from the firewall. On F-Series and Bronco, when the master cylinder studs are free of the dash panel, rotate the cylinder 105 degrees counter-clockwise to permit the interlock switch to exit the dash panel.
6. On 7.3L diesel and 7.5L gas engine vehicles, use a screwdriver or a similar tool and lift the two retaining tabs of the slave cylinder retaining bracket. Disengage the tabs from the bell housing lugs and then slide outward to remove. On 4.9/5.0/5.8L engine vehicles, depress the released ring on the tube quick disconnect and gently pull the connector free.
7. Remove the clutch hydraulic system from the vehicle.

Installation

1. Position the clutch fluid reservoir and master cylinder assembly into the firewall from inside the cab install the support bracket and two nuts and tighten.
2. Correctly route the hydraulic tubing and slave cylinder to the transmission bell housing.

   NOTE: Care must be taken during routing of the nylon line to keep away from engine exhaust system components.
3. Reinstall the clutch tube retaining clips.
4. On 7.3L diesel and 7.5L gas engines install the slave cylinder by pushing the slave cylinder push rod into the cylinder. Engage the push rod into the release lever and slide the slave cylinder into the bell housing lugs. Seat the cylinder into the recess in the lugs. For 4.9/5.0/5.8L engine vehicles, push the tube quick disconnect back onto the concentric slave cylinder fitting.

   NOTE: When installing a new hydraulic system, the external slave cylinder (7.3L diesel and 7.5L gas) contains a shipping strap that pre-positions the push rod for installation and also provides a bearing insert. Following installation of the new slave cylinder, the first actuation of the clutch pedal will break the shipping strap and give normal system operation.
5. From inside the cab, press the pushrod with the retainer bushing onto the cross-shaft lever pin until the bushing tabs snap into position in the groove.

   The flanged side of the bushing must be towards the cross-shaft lever.
6. Check the clutch reservoir and add fluid if required. Depress the clutch pedal at least ten times to verify smooth operation and proper release.

   NOTE: The proper fluid level is indicated by a step on the reservoir. Do not overfill. The upper portion of the reservoir must accept fluid that is displaced from the slave cylinder as the clutch wears.

Clutch Pedal

F-150—F-350, F-Super Duty, E-150 and Bronco

Removal

Refer to Figs. 6 and 7.

1. On F-Series and Bronco, disconnect the clutch pedal retracting spring from the clutch pedal and bracket. On Econoline models disconnect the

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barbed retainer bushing on the clutch/starter interlock switch rod from the clutch pedal (Fig. 2).

2. Remove the nut that retains the clutch pedal to the shaft and remove the clutch pedal. If the brake pedal is to be removed, refer to Section 12-30, Brake Pedal, Master Cylinder and Valves.

Installation

1. Position the clutch pedal on the shaft and install and tighten the nut.

2. Install the retracting spring. Make sure the spring engages the slots in the pedal and bracket.

NOTE: Spring installation is easier if the spring is first compressed in a vise and retained in a compressed state with mechanics wire until it is in place. Once in place cut the mechanics wire and remove.

3. On Econoline insert the clutch/starter interlock switch rod and barbed retainer bushing onto the clutch pedal pin, until the bushing barbs snap into position in the groove. If required, adjust the clip on the interlock switch rod as described in the Adjustment portion of this Section.

F-Super Duty Commercial Stripped Chassis

Removal

Refer to Fig. 3.

1. Disconnect the clutch master cylinder push rod from the clutch pedal.
2. Remove the through bolt and nut from the clutch pedal bracket.
3. Remove the clutch pedal with all the bushings, washer and the spacer.

Installation

1. Position the clutch pedal into the clutch pedal bracket with the bushings, washer and spacer.
2. Install the through bolt and nut. Tighten the nut to 68-94 N·m (50-70 ft-lb).
3. Install the clutch master cylinder push rod on the pedal and install the retaining spring.

Bleeding Procedure—Concentric Slave Cylinder

Refer to Fig. 8.

Under normal conditions disconnecting the clutch coupling will not introduce air into the system. However

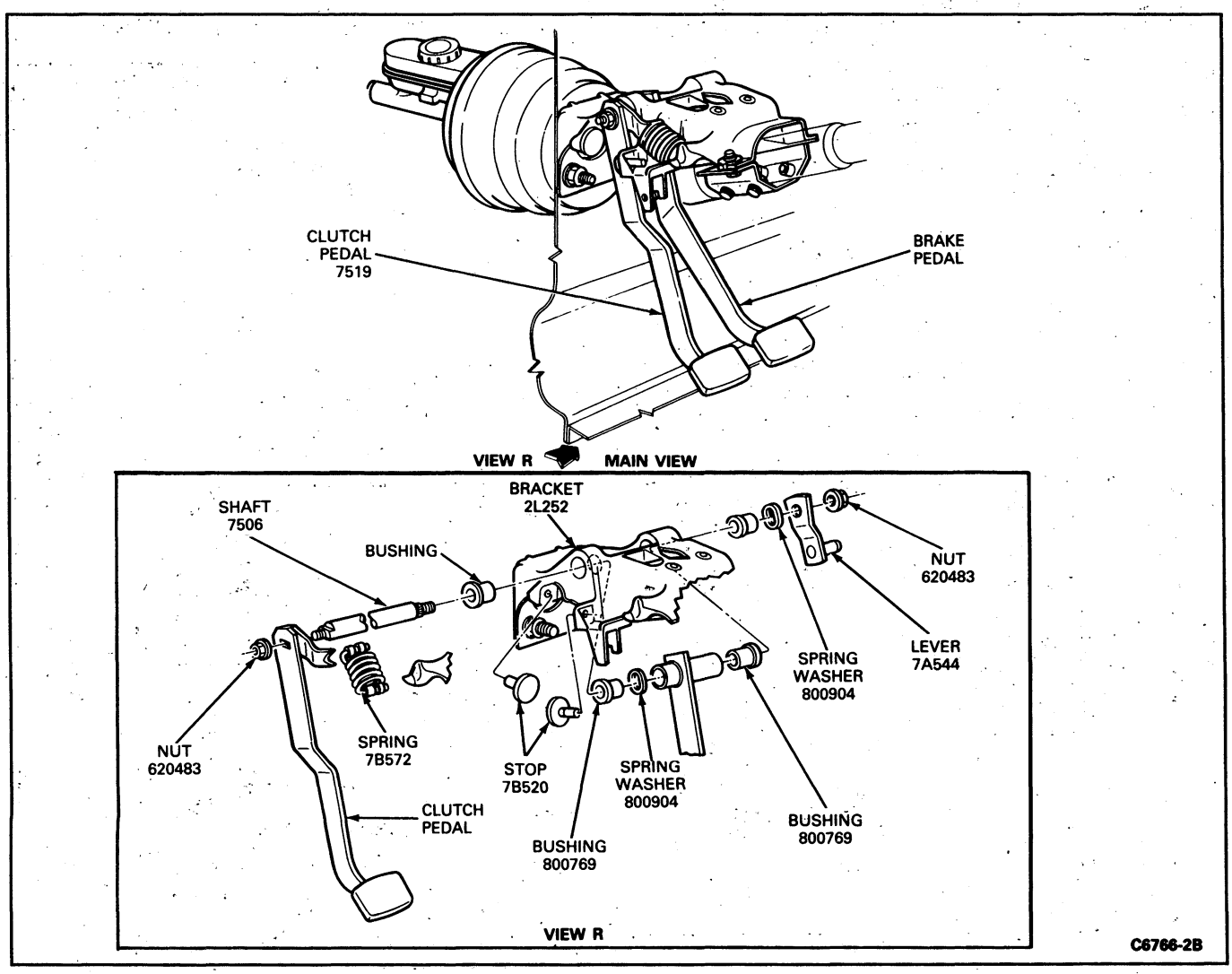


FIG. 6 Clutch Pedal Installation—F-150—F-350 and Bronco

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if there appears to be air in the system (spongy pedal, or insufficient bearing travel) the system must be bled. The following procedure is used with the hydraulic system installed on the vehicle. The largest portion of bleeding is carried out by gravity.

1. Clean dirt and grease from the cap.
2. Remove cap and diaphragm and fill reservoir to the top with approved brake fluid only. (Brake fluid must be certified to DOT 3 specification.)

NOTE: To keep brake fluid from entering the clutch housing, route a suitable rubber tube of appropriate inside diameter from the bleed screw to a container.

3. Loosen bleed screw (located in the slave cylinder body) next to the inlet connection.
4. Fluid will now begin to move from the master cylinder down the tube to the slave cylinder.

NOTE: The reservoir must be kept full at all times to ensure no additional introduction of air into the system.

5. It will be noticeable at this point, that bubbles will appear at the bleed screw outlet. This means that air is being expelled. When the slave is full, a steady flow of fluid will come from the slave outlet. Tighten bleed screw. NOTE: Maintain brake fluid level at the step in the reservoir at all times.
6. Depress the clutch pedal to the floor and hold for 1-2 seconds. Release pedal as rapidly as possible. Pedal must be released completely. Pause for 1-2 seconds. Repeat ten times.
7. Check fluid level in reservoir. The fluid should be level with the step when the diaphragm is removed.
8. Repeat steps 6 and 7 five times. Replace reservoir diaphragm and cap.
9. Hold pedal to floor, crack open bleed screw to allow any additional air to escape. (If bleed screw is opened too far, fluid will spray out.) Close screw then release pedal.
10. Check fluid level. The hydraulic system should now be fully bled and should release the clutch.

Bleed Procedure for External Slave Cylinder

7.3L Diesel and 7.5L Gas

1. Clean reservoir cap and slave cylinder in area of the tube connection.
2. Remove slave cylinder from the transmission bell housing.
3. Use 3/32 inch diameter punch to drive out the pin that holds the tube. Remove the tube from the slave cylinder and place the tube end into a container for waste fluid. The tube will still be connected to the master cylinder, so keep the reservoir cap tight to minimize fluid loss.

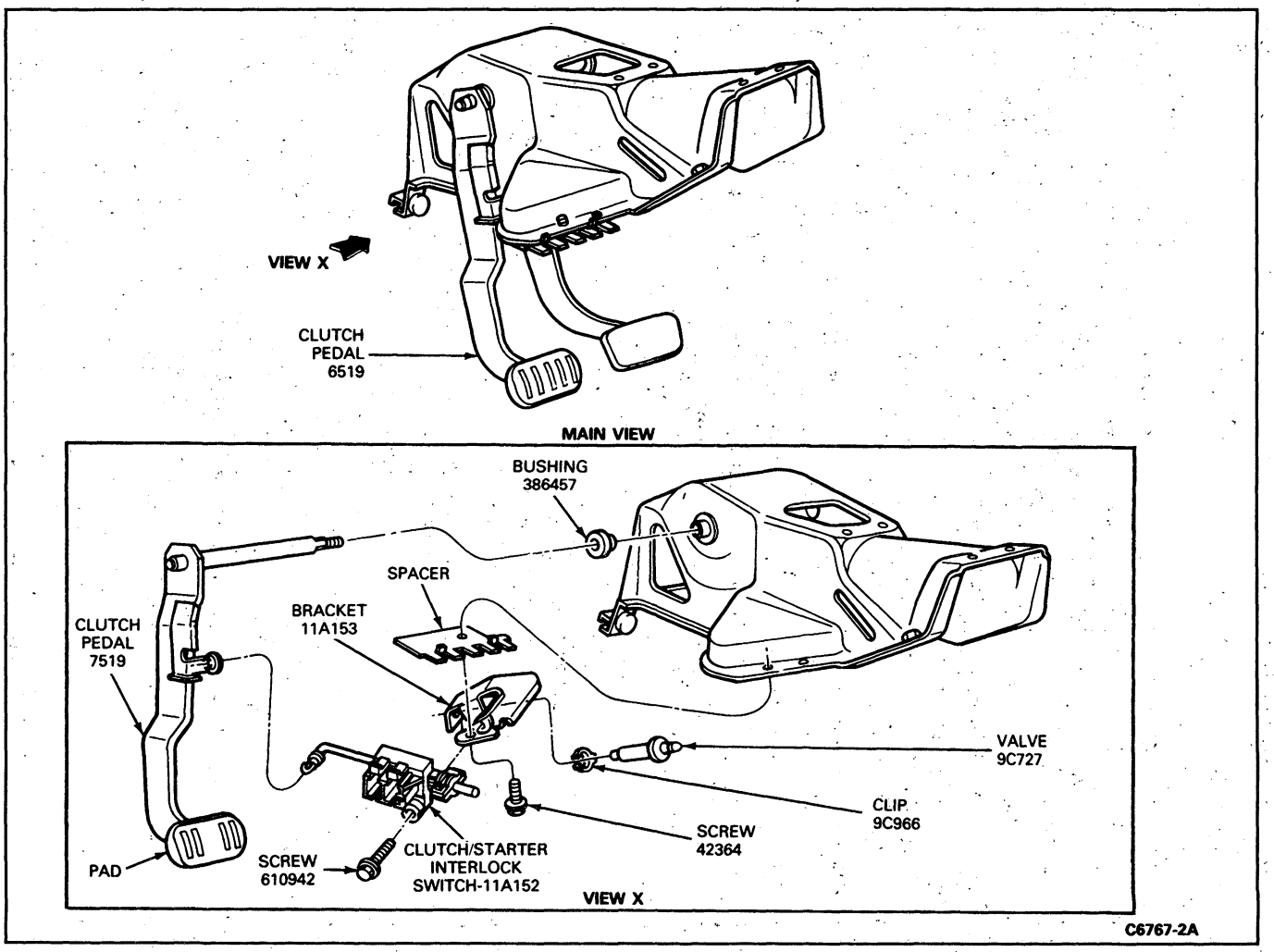


FIG. 7 Clutch Pedal Installation—E-150

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4. Hold slave cylinder so that connector port is at highest point, by tipping the cylinder to approximately 30 degrees (Fig. 9). Fill with approved Dot 3 brake fluid through connector port. It may be necessary to "rock" slave cylinder around or push gently on the pushrod to expel all the air. Pushing on pushrod too hard will cause fluid to spray out of the connector hole. Cleanliness is very important. Be sure not to let any moisture or foreign matter to enter the slave with the brake fluid.
5. When all of the air has been expelled from the slave cylinder and no more bubbles come out of the port hole, reinstall the slave cylinder back on the vehicle.

   NOTE: Some fluid will be expelled from the connector port, as the pushrod is compressed attaching it to the transmission and lever.
6. Gravity fill the master cylinder and tube as follows: Remove the reservoir cap and diaphragm fluid should flow out the open end of the tube into the waste container. Be sure to keep the reservoir full. When fluid is flowing out in a steady, uninterrupted flow and fluid is level with step in reservoir, reinstall the cap and diaphragm. Install end of tube into slave cylinder. Replace pin that holds tube to slave cylinder body.
7. System should now be bled and functioning properly. To verify proper system function set parking brake and put vehicle in neutral. Start vehicle and shift into reverse gear. If gears grind, other components may be causing the concern. Check the slave cylinder pushrod travel as detailed in Section 16-01 General Clutch Service.

Clutch Interlock Three Function Switch

F-Series and Bronco

Removal

Refer to Fig. 5.

1. Disconnect the wiring harness from the switch.
2. Pull down on the orientation clip to separate it from the tab on the switch.
3. Rotate the switch 1/2 turn to expose the plastic retainer.
4. Push the tabs together to allow the retainer to slide rearward and separate from the switch.
5. Remove the switch from the push rod.

Installation

1. Install the switch on the master cylinder push rod.
2. Install the plastic retainer.
3. Rotate the switch into the position required to attach the orientation clip.
4. Connect the wiring harness.

Hydraulic Clutch Line

Removal

1. Depress the white retainer bushing with disconnect tool T88T-70522-A, or equivalent, while pulling on the line.

Installation

1. Push the male connector onto the female connector of the clutch slave cylinder.

NOTE: No loss of fluid should occur during removal and installation, and bleeding should not normally be required unless the vehicle shows signs of hard shifting and lack of clutch reserve.

Clutch Release Bearing

4.9L, 5.0L and 5.8L Engines

Removal

1. Twist the release bearing and carrier assembly until resistance is felt (Fig. 11). Turning the

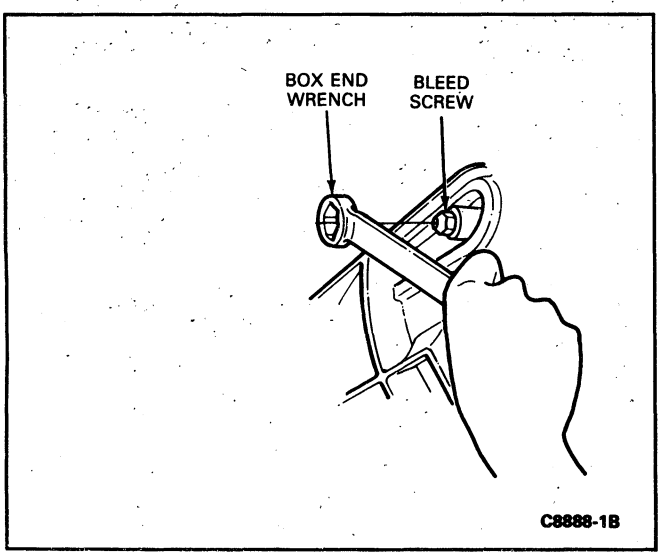


FIG. 8 Bleeding the Concentric Slave Cylinder

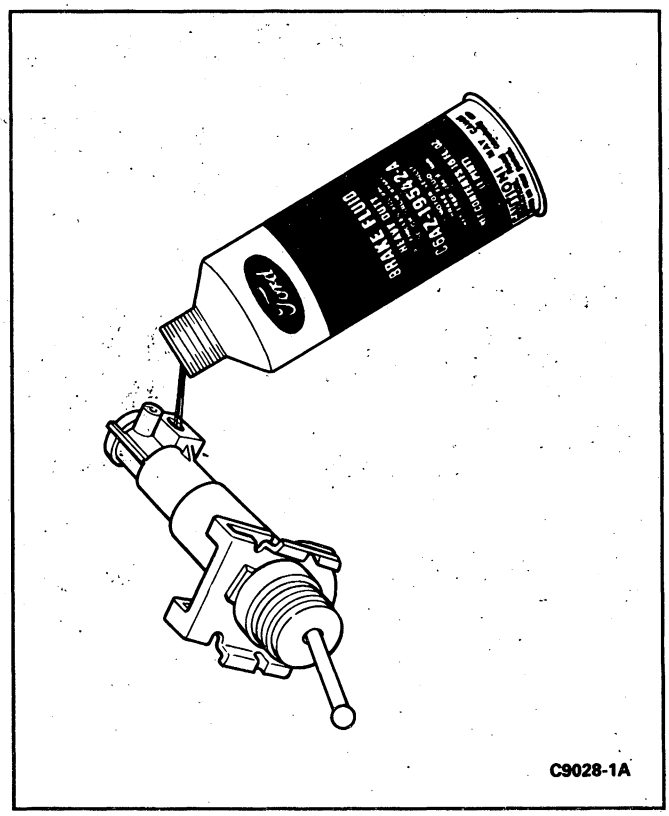


FIG. 9 Bleeding External Slave Cylinder

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assembly further will allow the preload spring to push the bearing assembly off the slave cylinder.

Installation

NOTE: Prior to re-installation, lubricate the bore of the bearing and bearing carrier with Ford Long Life Lubricant C1AZ-19590-BA(ESA-M1C75-B) or equivalent.

1. Install the release bearing assembly to the clutch slave cylinder by pushing into place.

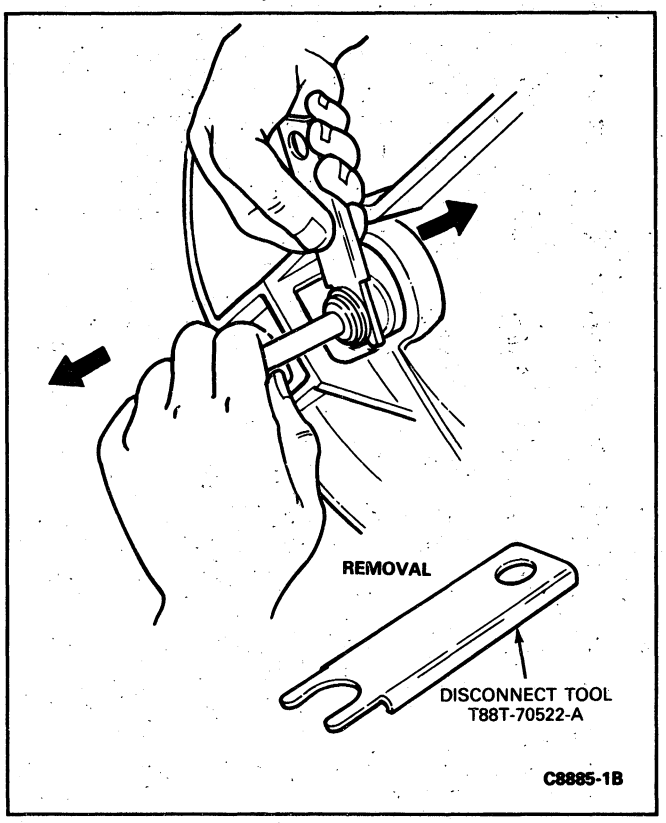


FIG. 10 Clutch Hydraulic Line Removal

Clutch Slave Cylinder

Concentric Slave Cylinder

Removal

1. Disconnect the coupling at the transmission with disconnect tool T88T-70522-A, or equivalent, by sliding the white plastic sleeve toward the slave cylinder while applying a slight tug on the tube (Fig. 10).
2. Remove the transmission as described in the appropriate transmission section.
3. Remove the bolts retaining the slave cylinder to the transmission (Fig. 12).
4. Remove the slave cylinder from the transmission input shaft.

Installation

1. Position the slave cylinder over the transmission input shaft with the bleed screw and coupling facing the left side of the transmission.
2. Install the slave cylinder attaching bolts, and tighten to 20-27 N·m (15-20 ft-lb).
3. Install the transmission as described in the appropriate transmission section.
4. Insert the male coupling into the female coupling on the clutch slave cylinder, and check that the connection is secure.
5. Bleed the clutch hydraulic system as required.

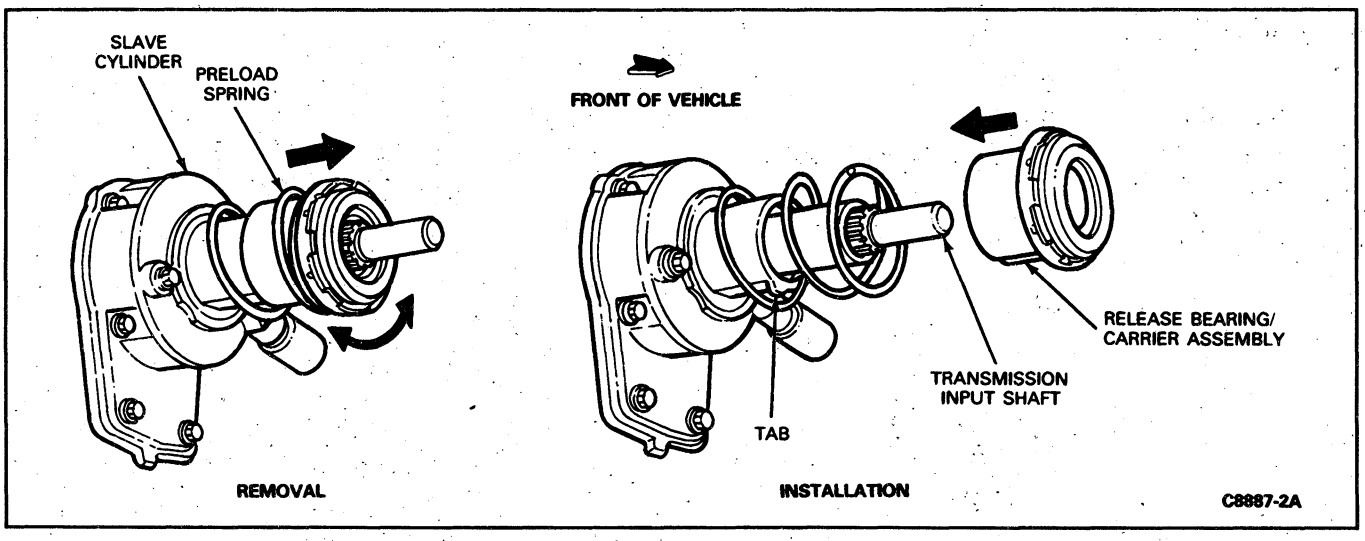


FIG. 11 Clutch Release Bearing Removal—with Concentric Slave Cylinder

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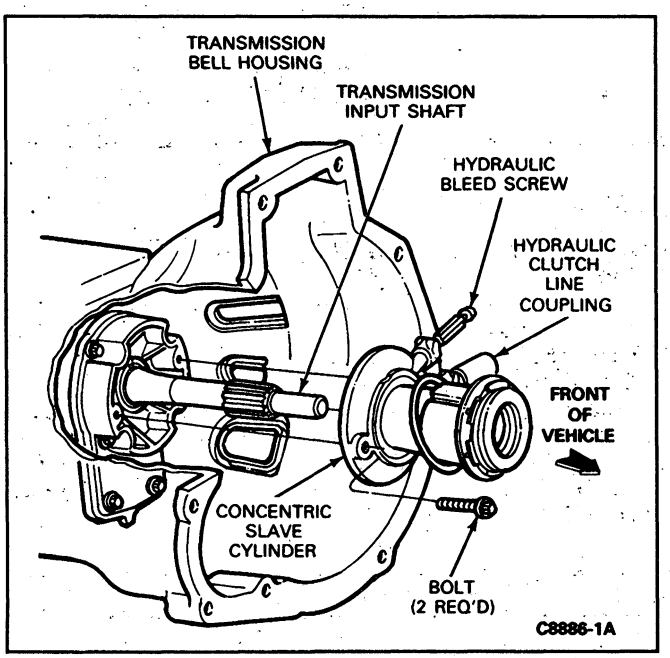


FIG. 12 Slave Cylinder Removal and Installation

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Application
T88T-70522-A	Hydraulic Line Disconnect Tool

CC9029-1A

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SECTION 16-10 General Manual Transmission Service

SUBJECT	PAGE
CLEANING AND INSPECTION	
Flywheel Clutch Face Runout	16-10-4
Sub-Assemblies	16-10-3
Bearings	16-10-4
Gear Shift Housing	16-10-3
Gears	16-10-4
Input Shaft	16-10-4
Output Shaft	16-10-4
Reverse Idler Gear	16-10-4
Seals and Gaskets	16-10-4
Synchronizer Blocking Rings	16-10-4
CLEANING AND INSPECTION (Cont'd)	
Sub-Assemblies (Cont'd)	
Thrust Washers and Bearing Covers	16-10-4
Transmission Case	16-10-3
Transmission	16-10-2
DESCRIPTION	
Identification	16-10-1
DIAGNOSIS	
Diagnosis Guides	16-10-1
SPECIFICATIONS	16-10-8
VEHICLE APPLICATION	16-10-1

VEHICLE APPLICATION

Applies to All E-150, E-350, F-150—F-350, Bronco, F-Super Duty and F-Super Duty Commercial Stripped Chassis Vehicles Equipped with Manual Transmissions.

DESCRIPTION

Identification

Transmission identification codes are found on the Vehicle Safety Compliance Certification Label found on the driver's door lock pillar. For identification of the label transmission code, refer to Section 10-00, Identification codes.

Manual transmissions have service identification tags to identify assemblies for service purposes. Ford truck manual transmissions have the identification tag located on the left side of the transmission case (Fig. 1 and 2).

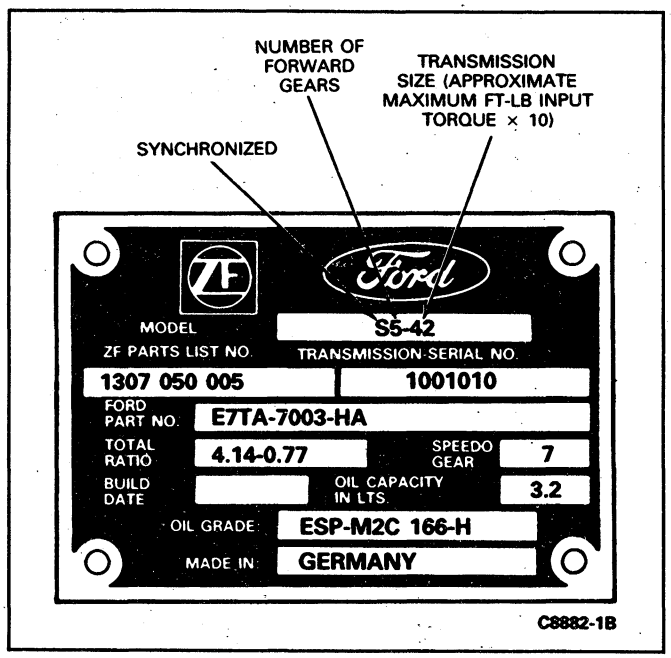


FIG. 1 Transmission Identification Tag—5 Speed Manual—ZF

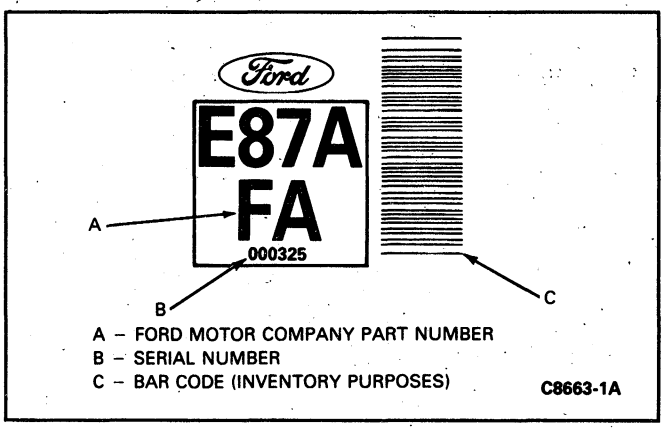


FIG. 2 Transmission Identification Tag—5 Speed Manual—Mazda

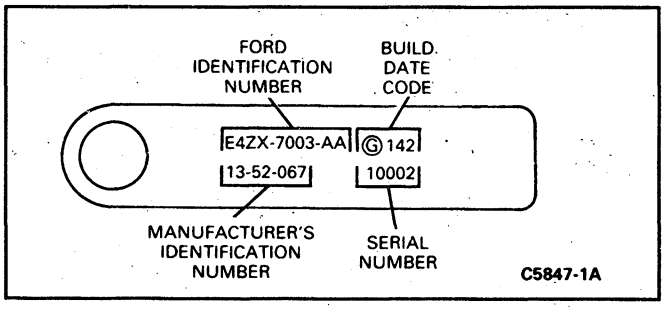


FIG. 3 Transmission Identification Tag-Borg-Warner 4-Speed Manual Transmission

Borg-Warner manual transmission have an identification tag located on the left middle bolt retaining the cover to the case. (Fig. 3).

DIAGNOSIS

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid when diagnosing manual transmissions.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission shifts hard.	1. Clutch does not completely release.	1. Check input shaft splines for lubrication. Refer to "Clutch does not disengage completely," Section 16-01, General Clutch Service.
	2. Transmission fluid low or improper type.	2. Add lubricant or change lubricant as required.
	3. Worn or damaged internal shift mechanism.	3. Remove transmission cover. Check internal shift mechanism by shifting into and out of all gears. Repair or replace as required.
	4. Binding of sliding gears and/or synchronizers.	4. Check for free movement of gears and synchronizers. Repair or replace as required.
	5. Housings and/or shafts out of alignment.	5. Remove transmission and check for binding condition between input shaft and engine crankshaft pilot bearing or bushing. Check flywheel housing alignment. Repair or replace as required.
Noisy in forward gears.*	1. Lubricant level low, or improper type.	1. Add lubricant, or refill with specified lubricant.
	2. Components grinding on transmission.	2. Check for screws, bolts, etc., of cab or other components grounding out. Correct as required.
	3. Component housing bolts loose.	3. Check torque on transmission to flywheel housing bolts, output shaft flange nut and flywheel housing to engine block bolts. Tighten bolts to specification.
	4. Flywheel housing to engine crankshaft alignment.	4. Check and align flywheel housing to engine crankshaft.
	5. Noisy bearings or gears.	5. Remove and disassemble transmission. Inspect input, output and countershaft bearings. Inspect speedometer gear and gear teeth for wear or damage. Replace as required.

*While verifying the condition, determine whether the noise is gear roll-over noise, release bearing rub or some other transmission related noise.
Gear roll-over noise, inherent in manual transmissions, is caused by the constant mesh gears turning at engine idle speed, while the clutch is engaged and the transmission is in neutral; and release bearing rub are sometimes mistaken for mainshaft bearing noise.
Gear roll-over noise will disappear when the clutch is disengaged or when the transmission is engaged in gear.
Release bearing rub will disengage when the clutch is engaged in the event that a bearing is damaged, the noise is more pronounced while engaged in gear under load or coast than in neutral.

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CLEANING AND INSPECTION

Transmission

Cleaning

After the transmission has been disassembled, soak the parts except the bearings, in a cleaning solvent until all the old lubricant is dissolved or loosened. Brush or scrape all foreign matter from the parts. Be careful not to damage any of the parts with the scraper.

An excessive amount of foreign material usually results from a bearing failure, gear seizure, tooth breakage, extreme synchronizer wear, or clashing gears. **In such cases, the input and output shaft bearings should be carefully inspected and replaced if necessary. Since countershaft bearings, output shaft pilot bearings, and reverse idler bearings are not so susceptible to damage from foreign material in the lubricant, they need not be replaced if they seem satisfactory.**

Wipe the parts or blow compressed air on them until they are thoroughly dry.

To clean the bearings, rotate them in clean solvent until all lubricant is removed. Hold the bearing assembly, to prevent it from rotating, and dry it with compressed air.

When the bearings are dry, lubricate them thoroughly with transmission lubricant, and cover them with a clean, lint-free cloth until ready for use.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Gears clash when shifting from one forward gear to another.	1. Engine idle speed too high.	1. Adjust engine idle speed.
	2. Pilot bearing binding.	2. Remove transmission and check for a binding condition between input shaft and engine crankshaft pilot bearing. Replace as required.
	3. Damaged gear teeth and/or synchronizer.	3. Disassemble transmission, repair or replace as required.
Transmission jumps out of gear.	1. Stiff shift boot. Improper fit of form isolation pad.	1. Replace shift boot if exceptionally stiff. Replace or rework pad to provide clearance.
	2. Loose transmission to engine mounting bolts, or loose levers.	2. Tighten transmission to engine block bolts to specifications. Loosen all bolts and reseat flywheel housing. Tighten all bolts. Tighten levers if necessary.
	3. Flywheel housing to engine crankshaft out of line.	3. Shim or replace housing as required.
	4. Crankshaft pilot bearing worn.	4. Replace bearing.
	5. Interior components damage.	5. Disassemble transmission. Inspect the synchronizer sleeves for free movement on their hubs. Inspect the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surface. Check countershaft cluster gear for excessive end play. Check shift forks for worn or loose mounting on shift rails. Check fork pads for excessive wear. Inspect synchronizer sliding sleeve and gear clutch teeth for wear or damage. Repair or replace as required.
	6. Worn gear teeth due to partial engagement.	6. Replace worn or damaged gears.

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Inspection

Inspect all transmission parts before reassembly to determine if they should be replaced.

Sub-Assemblies

Gear Shift Housing

Check the operation and condition of the shift levers, forks, and shift rails. If binding occurs when the levers are operated, disassemble the housing assembly, and replace the worn or damaged parts.

Transmission Case

Inspect the case for cracks, worn or damaged bearing bores, damaged threads, or similar damage. If such is found, replace the case.

Holes smaller than 6.35mm (1/4 inch) diameter, such as sand holes or casting porosity can be repaired using Metallic Plastic Repair Kit, Part No. C6AZ-19554-A (M3D35-A) or equivalent as directed.

Holes larger than 6.35mm (1/4 inch) can be repaired by drilling, tapping and plugging.

The recommended procedure for using the Metallic Plastic Repair Kit is as follows:

Steam clean the transmission or transfer unit case to remove grease, oil, or road dirt. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.

1. Prepare the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porous area to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole.
2. Mix the metallic plastic base and hardener as directed on the container. Stir thoroughly until uniform.
3. Apply the repair mixture with a suitable clean tool (putty knife, wood spoon, etc.), forcing the mixture into the hole or porosity.
4. Allow the repair mixture to harden by either of two methods: heat cure with a 250-watt lamp placed 254mm (10 inches) from the repaired surface, or air dry for 10 to 12 hours at temperatures above 10°C (50°F).

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission will not shift into one gear — all others OK.	1. Manual-shift linkage damaged or worn.	1. Lubricate, repair or replace parts as required.
	2. Back-up switch ball frozen.	2. If reverse is problem, check back-up switch for ball frozen in extended position (if so equipped).
	3. Internal components.	3. Remove transmission. Inspect shift rail and fork system synchronizer system and gear clutch teeth for restricted travel. Repair or replace as required.

CC5205-2B

5. Sand or grind the repaired area, blending it with the general contour of the surrounding surface. **Do not use this method to repair casting cracks.**

Bearings

Examine the bearing assemblies (Fig. 4) for cracked cups or races. Check the races for roughness. Inspect the balls and rollers for looseness, wear, chipping, flaking or other damage. Check the bearings for binding on the shafts or looseness in the bores. If any of these conditions are present, replace the bearings.

Gears

Some forms of grind marks and tooth wear contact patterns are acceptable and should not be considered as a source of gear noise. Grind marks are distinctive from wear or damage which are local swells (polished raised projections), nicks and chips. All gears have possible factory repair grind marks. Phosphate coated gears are especially easy to recognize since the grind operation removes a patch of phosphate and base metal exposing the lighter metallic color. Figs. 5, 6 and 7 show normal and abnormal gear tooth contact patterns, normal tooling marks, and approved and unapproved chip/nick removal procedures.

Reverse Idler Gear

Replace the reverse idler gear if the gear, bushing or roller bearings are badly worn or if the teeth are chipped or burred. Replace the reverse idler gear shaft if it is excessively worn or scored.

Input Shaft

Replace the input shaft if it is worn, bent, or twisted, if the gear has chipped, nicked, worn, or missing teeth, or if the cone surface is damaged. If the pilot bearing bore is scored, replace the gear and gear rollers.

Output Shaft

Replace all output shaft gears that are chipped, nicked, burred, or badly worn. Replace the output shaft if it is out of round or worn, or if the pilot bearing surface is scored.

Replace the speedometer drive gear if the gear teeth are worn or broken. Be sure to install the correct replacement gear.

Thrust Washers and Bearing Covers

Check the surfaces of all thrust washers. Replace washers that are scored and/or reduced in thickness.

Replace bearing covers that are grooved or showing wear from the thrust or adjacent bearings. Check the oil return threads in the bearing covers. If the sealing action of the threads has been destroyed by contact from the input or output shafts, replace the covers.

Synchronizer Blocking Rings

Inspect the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surfaces (must have machined grooves). With the blocking ring on the cone, the distance between the face of the gear clutching teeth and the face of the blocking ring must not be less than 0.6mm (0.024 inch) for ZF 1-, 2, 3, 4 and 5 synchronizers, 0.4mm (0.016 inch) for ZF Reverse synchronizer, and 1.5mm (0.059 inch) for Mazda synchronizers.

Check the synchronizer sleeves for free movement on the hubs. Make sure the alignment marks (etched or paint marks) are properly indexed.

Replace the seal in the input shaft bearing retainer.

Replace the seals on the cam and shafts.

Seals and Gaskets

Examine and replace if necessary, input and output shaft bearing retainer seals and gaskets.

Flywheel Clutch Face Runout

Install a dial indicator Tool D78P- 4201-F, G or equivalent so that the indicator point bears against the flywheel face (Fig. 8). Turn the flywheel making sure that it is full forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If the flywheel clutch face runout exceeds specifications, (refer to the appropriate engine Section) remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft-flywheel mounting face if the mounting face flange runout is excessive. If the ring gear runout exceeds 0.25mm (0.010 inch), check installation of the gear to the flywheel flange. If it is not properly seated, re-install it to the flywheel. If it is properly seated, replace it. Refer to Ring Gear Replacement in Section 21-01 General Gasoline Engine Service, in the Light Truck—Engine manual volume B,* for the proper procedure. For flywheel runout specifications, refer to the appropriate engine Section under Specifications.

*Can be purchased separately.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission is locked in one gear. It cannot be shifted out of that gear.	1. Internal components.	1. Remove transmission. Inspect problem gears, shift rails and forks and synchronizer for wear or damage. Repair as required.
	2. Loose fork on rail.	2. Check shift rail interlock system.
Transfer case makes noise.	1. Incorrect tire inflation pressures and/or incorrect size tires and wheels.	1. Assure that all tires and wheels are the same size, and that inflation pressures are correct.
	2. Excessive tire tread wear.	2. Check tire tread wear to see if there is more than .06 inch difference in tread wear between front and rear. Interchange one front and one rear wheel. Re-inflate tires to specifications.
	3. Internal components.	3. Operate vehicle in all transmission gears with transfer case in 2HI, or Hi range. — If there is noise in transmission in neutral gear, or in some gears and not in others, remove and repair transmission. — If there is noise in all gears, operate vehicle in all transfer case ranges. If noisy in all ranges or HI range only, disassemble transfer case. Check input gear, intermediate and front output shaft gear for damage. Replace as required. If noisy in LO range only, inspect intermediate gear and sliding gears for damage. Replace as required.
4-wheel drive transfer case jumps out of gear.	1. Incomplete shift linkage travel.	1. Adjust linkage to provide complete gear engagement.
	2. Loose mounting bolts.	2. Tighten mounting bolts.
	3. Front and rear driveshaft slip yokes dry or loose.	3. Lubricate and repair slip yokes as required. Tighten flange yoke attaching nut to specifications.
	4. Internal components.	4. Disassemble transfer case. Inspect sliding clutch hub and gear clutch teeth for damage. Replace as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission leaks.	1. Improper amount of lubricant — wrong type.	1. Check level and type. Fill to bottom of filler plug hole.
	2. Other component leaking.	2. Identify leaking fluid as engine, power steering or transmission. Repair as required.
	3. False report.	3. Remove all traces of lube on exposed transmission surfaces. Check vent for free breathing. Operate transmission and inspect for new leakage. Repair as required.
	4. Internal components.	4. Remove transmission. Inspect for leaks at the input shaft bearing retainer seal and shift rail expansion plug. Inspect for leaks at the top cover gasket. Inspect case for sand holes or cracks. Repair or replace as required.
	5. Improper installation torque on fill and drain plugs.	5. Tighten to specified torque value.

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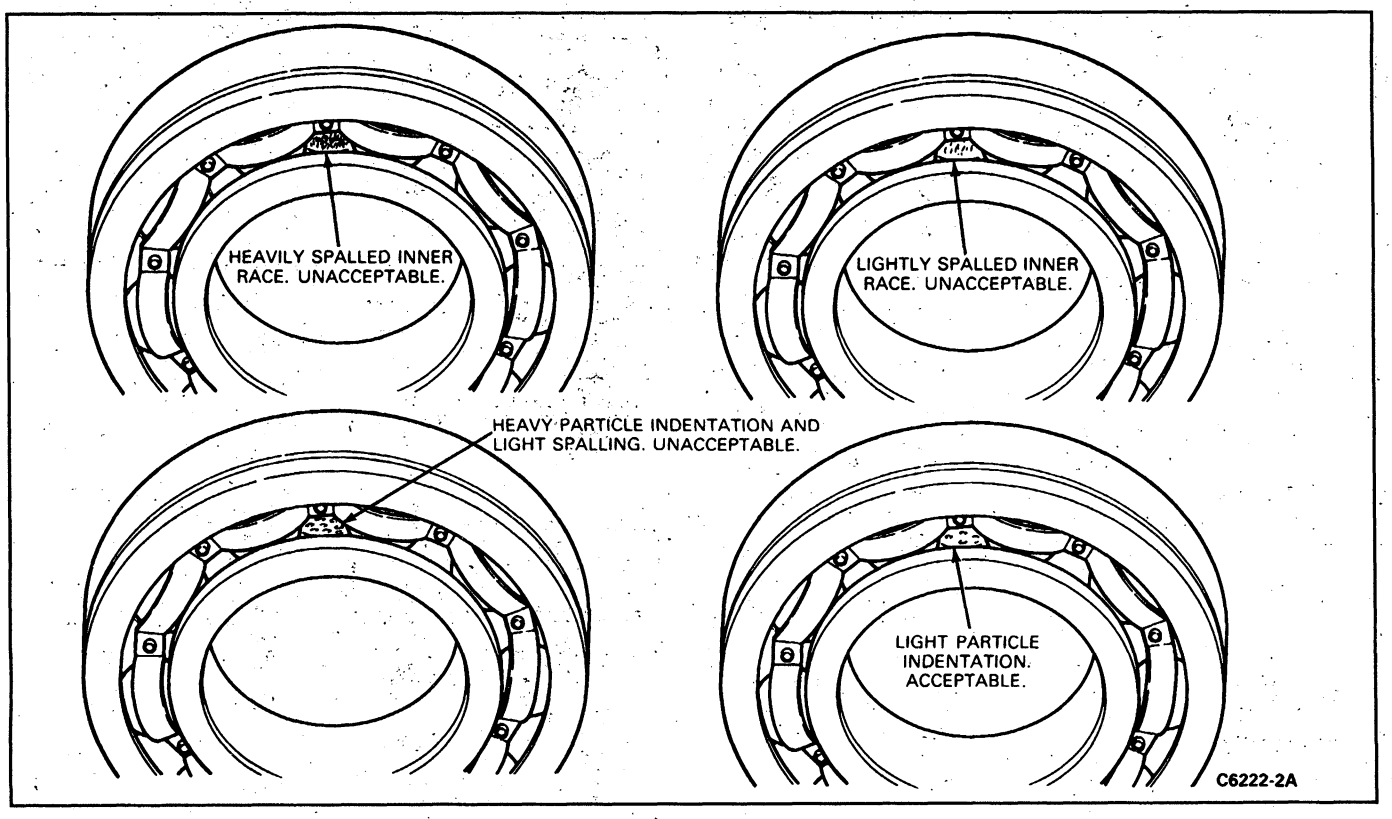


FIG. 4 Ball Bearing Inspection

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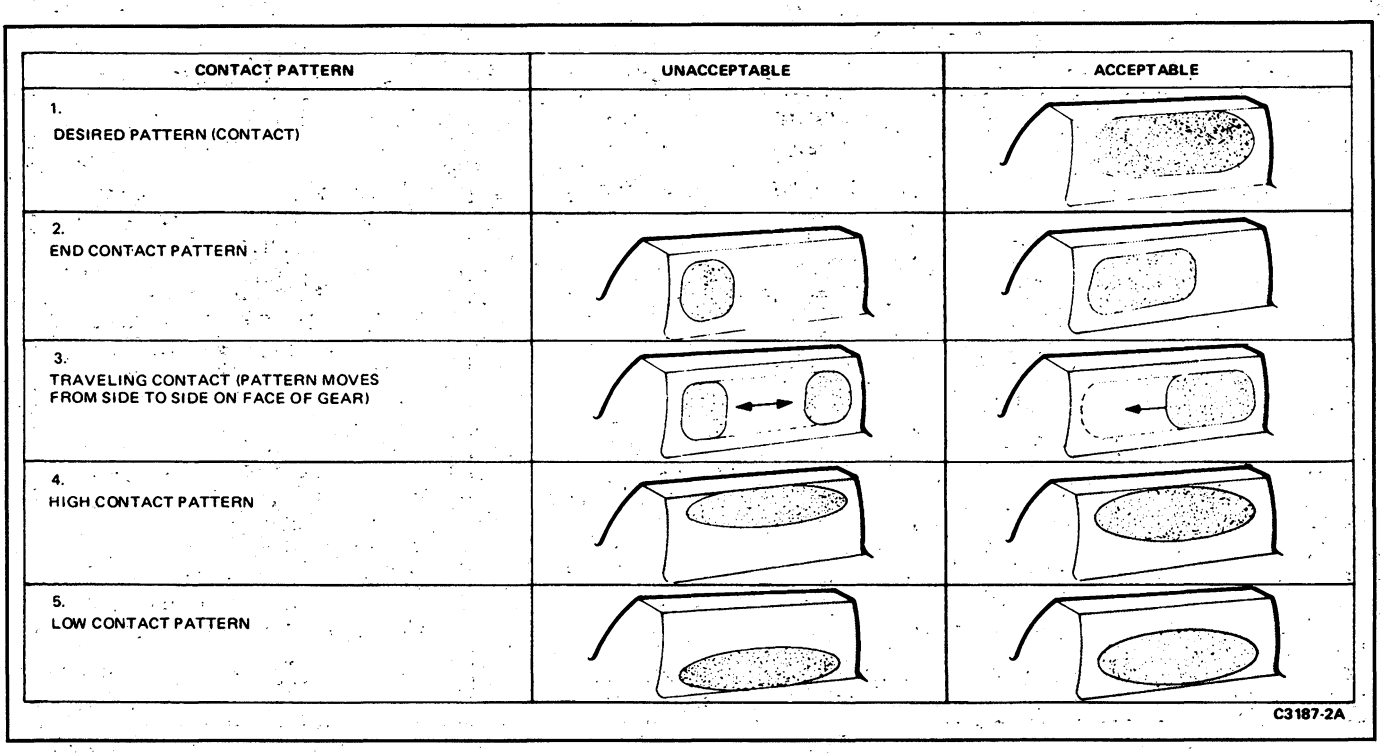


FIG. 5 Typical Transmission Gear Tooth Contact Patterns

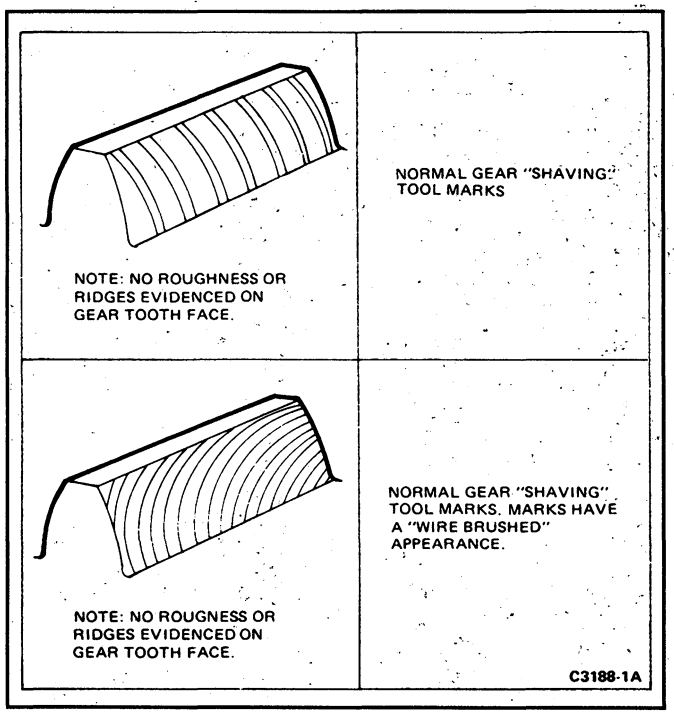


FIG. 6 Normal Tool Marks—Typical

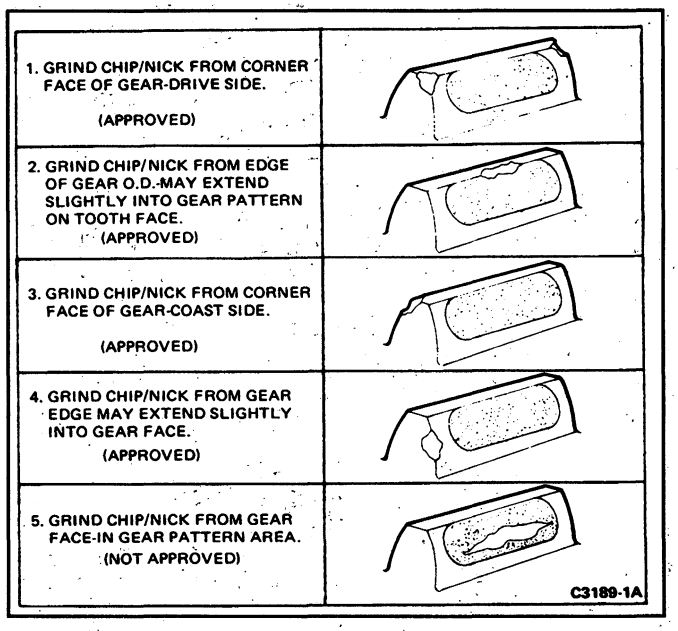


FIG. 7 Approved Transmission Gear Tooth Chip/Nick Removal Procedure

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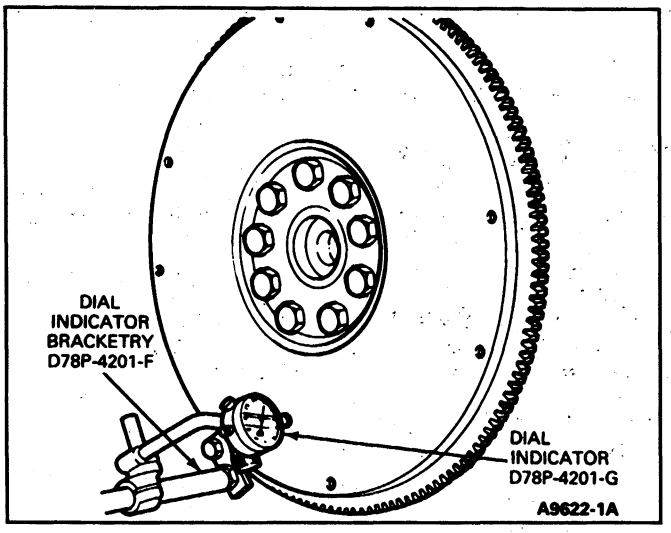


FIG. 8 Checking Flywheel Face Runout—Manual Transmission

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
D78P-4201-B	Dial Indicator with Magnetic Base	Universal
TOOL-4201-C, D78P-4201, F, G	Dial Indicator with Bracketry	Universal

CC4860-2C

MANUAL TRANSMISSION LUBRICANT CAPACITIES①

Transmission	Approximate Refill Capacity	
	U.S. Pints	Liters
Mazda M50D Five Speed Transmission②	7.6	3.6
ZF M50D-HD Five Speed Transmission③	6.8	3.2
Warner Four-Speed Transmission Without Extension — (4x4)④	6.5	3.0

①Fill transmissions to bottom of filler hole.
②Fill with ESP-MC2138-CJ (DEXRON II®) or equivalent.
③Fill with ESP-M2C166-H (Motorcraft Mercon) or equivalent.
④Use Manual Transmission Lubricant, D8DZ-19C547-A (ESP-M2C83-C) or equivalent.

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SECTION 16-20 Mazda M5OD Five-Speed Manual Overdrive Transmission

SUBJECT	PAGE
CLEANING AND INSPECTION	
Ball Bearing Inspection	16-20-21
Cleaning	16-20-20
General Inspection	16-20-20
Transmission	16-20-23
DESCRIPTION	16-20-1
DIAGNOSIS AND TESTING	16-20-1
DISASSEMBLY AND ASSEMBLY	
Transmission	16-20-4
IDENTIFICATION	16-20-1
REMOVAL AND INSTALLATION	
Crossmember	16-20-3
REMOVAL AND INSTALLATION (Cont'd.)	
Transmission (4x2)	16-20-2
Transmission (4x4)	16-20-2
SPECIAL SERVICE TOOLS	16-20-35
SPECIFICATIONS	16-20-34
SUBASSEMBLIES	
Countershaft	16-20-16
Input Shaft	16-20-12
Output Shaft	16-20-13
Reverse Idler Gear Shaft	16-20-17
Top Cover	16-20-18
VEHICLE APPLICATION	16-20-1

VEHICLE APPLICATION

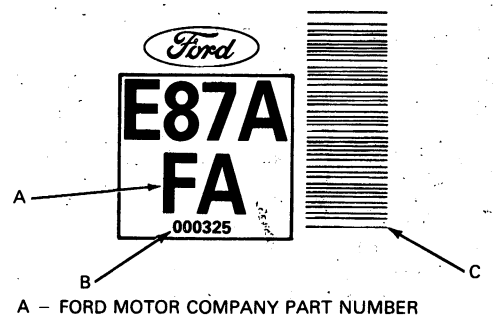
F-Series, Bronco and Econoline vehicles.

DESCRIPTION

The M5OD is a top shift, fully synchronized, five-speed manual transmission, equipped with an overdrive fifth gear ratio. All gear changes including reverse are accomplished with synchronizer sleeves.

The transmission main case, top cover, and extension housing are constructed of aluminum alloy. Steel bearing race inserts provide durability in appropriate areas.

The extension housing contains a bronze alloy bushing. This bushing cannot be serviced. The extension housing must be replaced as a unit if the bushing requires service.



A – FORD MOTOR COMPANY PART NUMBER
B – SERIAL NUMBER
C – BAR CODE (INVENTORY PURPOSES)

C8663-1A

IDENTIFICATION

The Vehicle Safety Compliance Certification Label (located on the driver's door lock pillar) lists applicable transmission identification codes. For identification of the label codes, refer to Section 10-00, Identification codes.

Manual transmissions are equipped with service identification tags. The M5OD transmission service tag is located on the driver's side of the transmission.

DIAGNOSIS AND TESTING

For diagnosis and testing procedures, refer to Section 16-10, General Manual Transmission Service.

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REMOVAL AND INSTALLATION

Transmission (4x2)

Removal

1. Shift the transmission into neutral.
2. Remove the carpet or floor mat. Refer to Section 45-26, Carpets and Floor Mats, for removal procedure.
3. Remove the shifter boot retainer screws and slide the boot up the shift lever shaft.
4. Remove the shift lever retaining bolt and remove the shift lever.
5. Raise the vehicle on a hoist and position safety stands under the vehicle.
6. Disconnect the speedometer cable.
7. Disconnect the back-up lamp switch located at the top left hand side of the transmission.
8. Remove the drain plug and drain the oil from the transmission.
9. Position a transmission jack, such as Rotunda Transmission Jack 077-00008 or equivalent under the transmission.
10. Disconnect the driveshaft from the transmission and wire it to one side. Refer to Section 16-61, Driveshaft.
11. Disconnect the clutch slave cylinder hydraulic line. Refer to Section 16-04, Hydraulic Clutch System.
12. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember removal and installation in this Section.
13. Remove the bolts that retain the transmission to the engine block.
14. Move the transmission to the rear until the input shaft clears the engine flywheel. Lower the transmission from the vehicle.

Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent. Install guide studs in the engine block and raise the transmission until the input shaft splines are aligned with the clutch disc splines.
2. Slide the transmission forward on the guide studs until it is in position. Install the attaching bolts and tighten to 54-67 N·m (40-50 ft-lb). Remove the guide studs and install the remaining bolts. Tighten the two bolts for the lower plate to 12-16 N·m (9-12 ft-lb).
3. Install the crossmember as described under Crossmember Removal and Installation in this Section. Position the insulator and retainer between the transmission and crossmember. Install bolts and tighten to 81-108 N·m (60-80 ft-lb). Install the nut retaining the insulator and retainer to crossmember. Tighten to 81-108 N·m (60-80 ft-lb). Remove the transmission jack.
4. Connect the speedometer cable and driven gear and clutch hydraulic line.
5. Connect the backup lamp switch.
6. Connect the driveshaft. Refer to Section 15-61, Driveshaft, for procedure.
7. Install the shift lever retaining bolt and tighten to specifications.
8. Slide the shifter boot into position on the shifter shaft, and install the boot retaining screws.
9. Install the isolator pad assembly. Install the floor pan cover and floor mat.

Transmission (4x4)

Removal

1. Shift the transmission into neutral.
2. Remove the carpet or floor mat. Refer to Section 45-26, Carpets and Floor Mats, for removal procedure.
3. Remove the shifter boot retainer screws and slide the boot up the shift lever shaft.
4. Remove the shift lever retaining bolt and remove the shift lever.
5. Raise the vehicle on a hoist.
6. Remove the drain plugs and drain the transmission and transfer case.
7. Disconnect the rear driveshaft from the transfer case and wire it out of the way. Refer to Section 15-61, Driveshafts.
8. Disconnect the front driveshaft from the transfer case and wire it out of the way. Refer to Section 15-61, Driveshafts.
9. Disconnect the backup lamp switch.
10. Remove the speedometer cable from the transfer case.
11. If equipped, remove the skid pad from beneath the transfer case.
12. Position a transmission jack such as Rotunda Transmission Jack 077-00008, under the transfer case. Remove the six bolts holding the transfer case to the transmission and carefully lower the transfer case from the vehicle, using care to ensure that the transfer case shift lever clears the opening in the floor pan.
13. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember removal and installation in this Section.
14. Remove the bolts that retain the transmission to the engine block.
15. Move the transmission to the rear until the input shaft clears the engine flywheel housing. Lower the transmission from the vehicle.

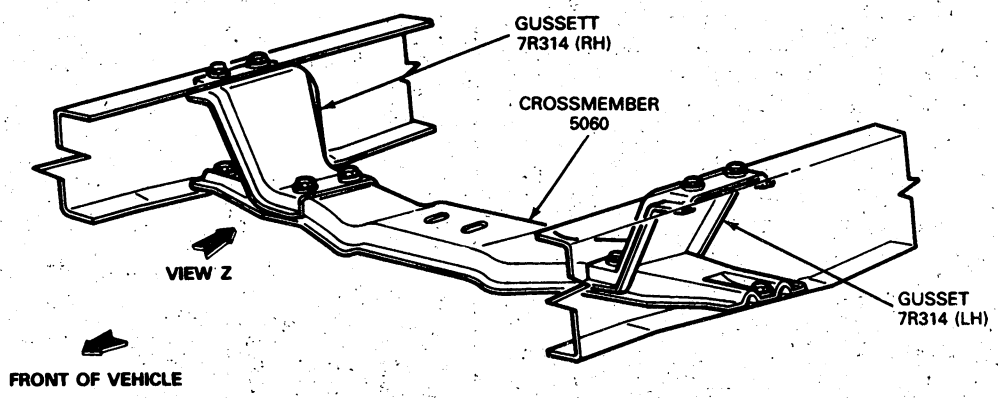
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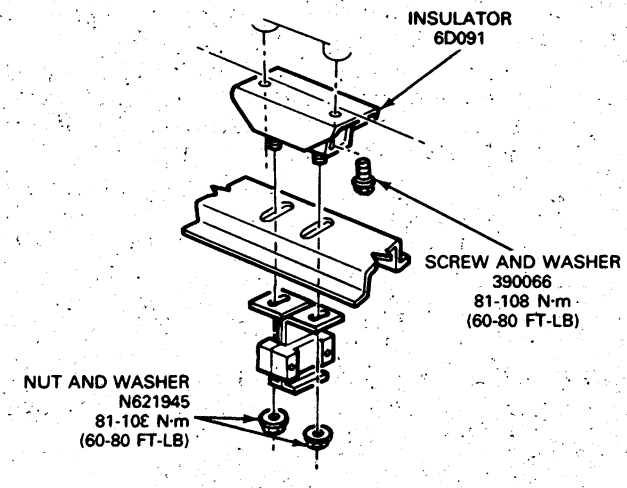
REMOVAL AND INSTALLATION (Continued)

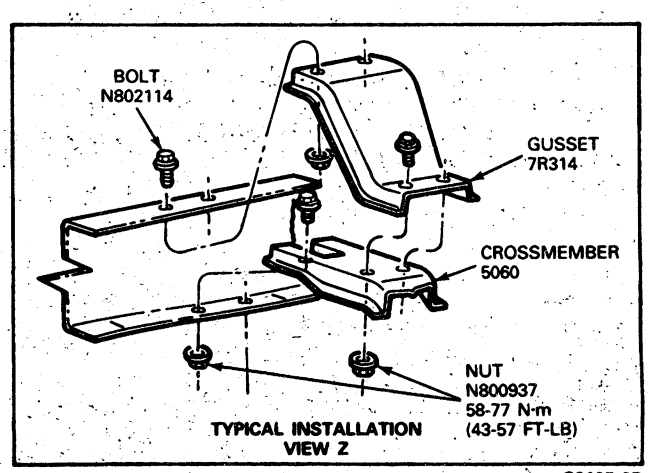
Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent, and install two guide studs in the transmission front case top holes, to guide the transmission into position. Join together the transmission and engine block mating surfaces.
2. Install the two lower bolts and tighten to 54-67 N·m (40-50 ft-lbs). Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the retaining bolts. Refer to crossmember installation in this Section. Tighten the bolts to 60-80 N·m (45-60 ft-lbs).
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack. Position the transfer case on the transmission, using care to guide the transfer case shift lever through the opening in the floor pan. Install the gasket and six retaining bolts. Tighten the bolts to specifications listed in the appropriate transfer case section in Group 16 in this manual.
6. Install the speedometer cable to the transfer case.
7. Connect the front driveshaft to the transfer case yoke or flange.
8. Connect the rear driveshaft to the transfer case yoke or flange.
9. Fill transfer case and transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX E4A2-19582-B (ESP-M2C188-CJ) or equivalent automatic transmission fluid.
10. Connect the back-up lamp switch.
11. Lower vehicle.
12. Install the shift lever retaining bolt and tighten to specifications.
13. Slide the shifter boot into position on the shifter shaft, and install the boot retaining screws.
14. Install the isolator pad assembly. Install the floor pan cover and floor mat.
15. Install the shift ball on the transfer case shift lever.

Crossmember







C8195-2B

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REMOVAL AND INSTALLATION (Continued)

Removal

1. Raise vehicle on a hoist.
2. Remove skid plate, if so equipped. Remove heat shield from catalytic converter.

CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extremely high temperatures generated by the converter.

3. Remove two nuts connecting upper gusset to frame on both sides of frame.
4. Remove nut and bolt assembly connecting gusset to crossmember. Remove gusset on left side.
5. Remove bolts holding transmission to transmission support plate on crossmember.
6. Raise transmission with a transmission jack such as Rotunda Transmission Jack, 077-00008 or equivalent.
7. Remove the nut and bolt assemblies connecting the support plate to the crossmember. Remove support plate. Remove right gusset.
8. Remove nut and bolt assemblies connecting crossmember to frame. Remove crossmember.

Installation

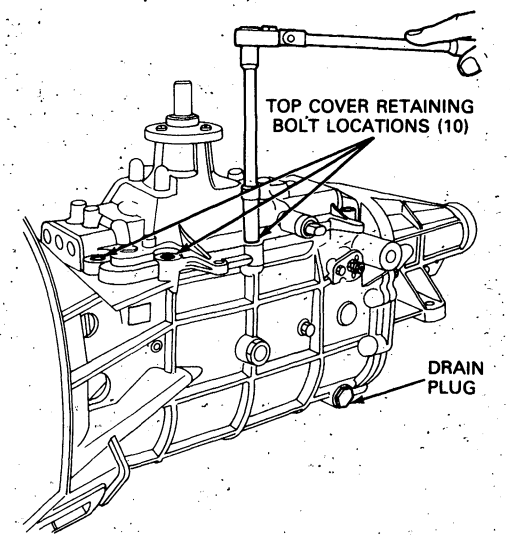
1. Install crossmember and transmission support plate, and position right and left gussets on bolt on frame. Install nuts on upper gusset to frame bolts and tighten to specifications.
2. Install crossmember to frame nut and bolt assembly and tighten to specification.
3. Install nut and bolt assembly connecting gusset to crossmember and tighten to specification.
4. Install nut and bolt assemblies connecting transmission support plate to crossmember and tighten to specification.
5. Lower the transmission.
6. Install bolts connecting transmission support plate to transmission and tighten to specification.
7. Install skid plate, if so equipped. Install heat shield over catalytic converter. Tighten all nuts and bolts to specification.

DISASSEMBLY AND ASSEMBLY

Transmission

Disassembly

1. Using a 24mm wrench, remove transmission drain plug and drain transmission.



C8414-1A

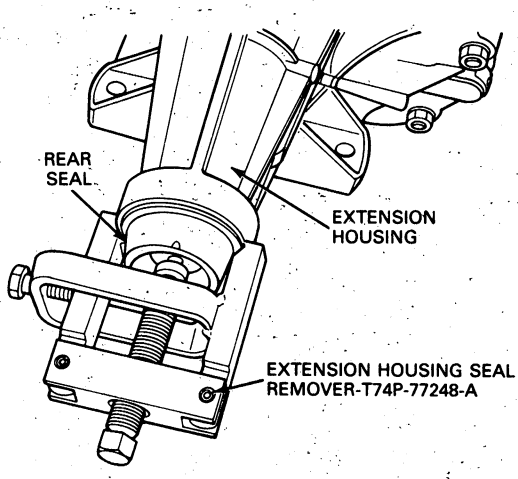
2. Remove shift lever and dust boot if necessary.
3. Using a 12mm wrench, remove ten top cover assembly retaining bolts. Remove top cover assembly.

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DISASSEMBLY AND ASSEMBLY (Continued)

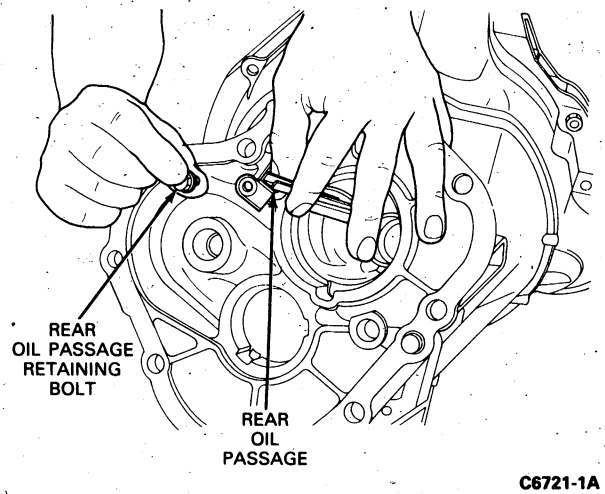
4. Using a 14mm socket, remove nine extension housing retaining bolts. Pry gently at locations provided on extension housing and transmission case. Remove extension housing from case.

NOTE: On 4 x 2 models, if it is necessary to remove rear seal from extension housing, extension housing must be installed to transmission case. Remove extension housing rear seal using Seal Remover T74P-77248-A or equivalent.



C6720-1A

5. If necessary, remove rear oil passage from extension housing using a 10mm socket (4 x 2 models only).



C6721-1A

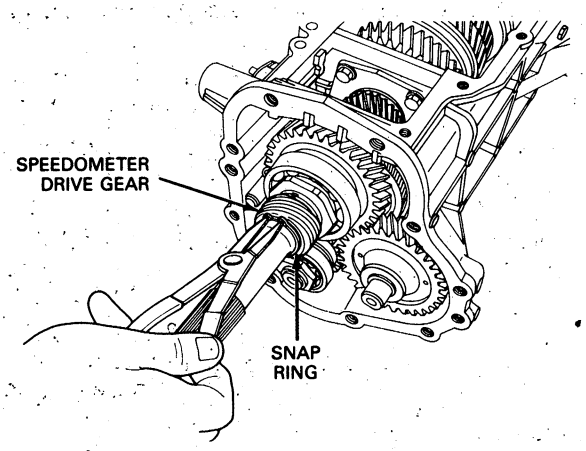
6. Remove and discard anti-spill oil seal from output shaft (On 4 x 2 models).

7. Remove the speedometer drive gear and steel ball (On 4 x 2 models).

NOTE: For reference during assembly, observe and record speedometer drive gear color. Depending upon application, one of two different speedometer drive gears may be installed. It will be color-coded either green or white. Speedometer drive gear colors and corresponding part numbers are as follows:

White (Natural)—E8TZ-17285-B

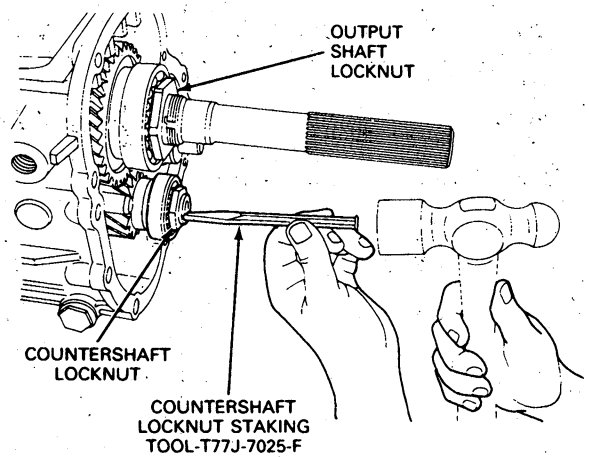
Green—E8TZ-17285-C



C6722-1A

8. Lock transmission into first and third gears.
9. Using Countershaft Locknut Staking Tool T77J-7025-F or equivalent, release the staked areas securing output shaft and countershaft locknuts.

CAUTION: Staked areas of locknuts must be fully released or damage to shaft threads will result.

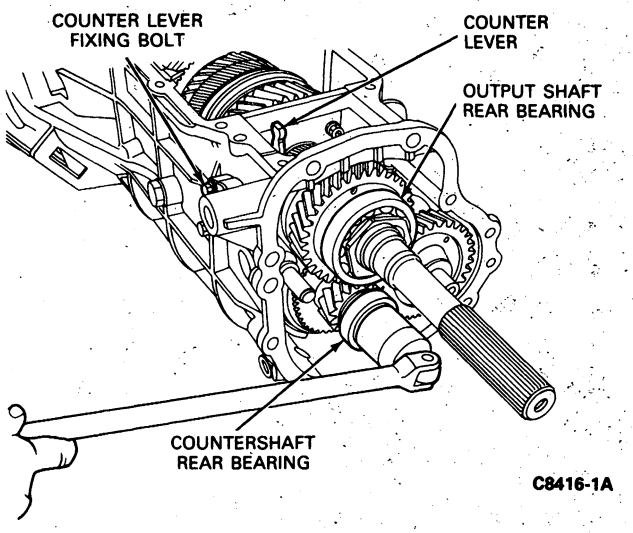


C6723-1A

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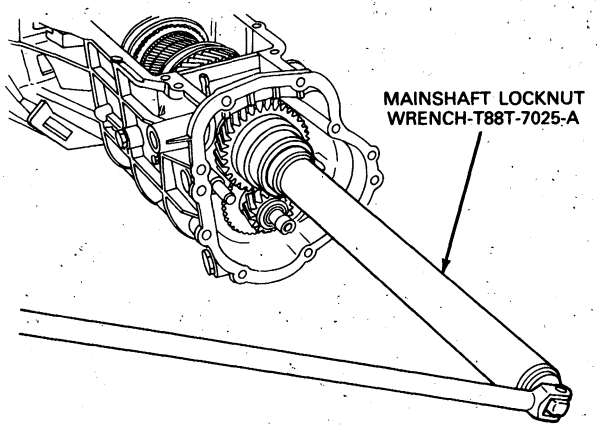
DISASSEMBLY AND ASSEMBLY (Continued)

10. Using a 32mm socket, remove and discard the countershaft rear bearing locknut. Remove the countershaft bearing and thrust washer.



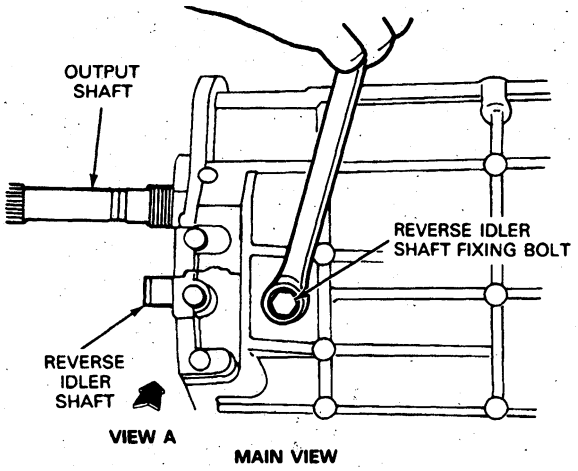
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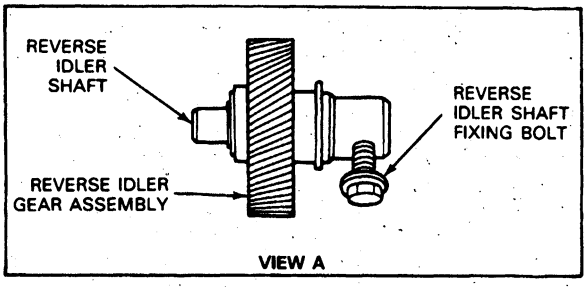
11. Using Mainshaft Locknut Wrench T88T-7025-A and Remover Tube T75L-7025-B or equivalents, remove and discard output shaft locknut.



C8417-1A

12. Using a 17mm wrench, remove reverse idler shaft fixing bolt. Remove reverse idler gear assembly by grasping and pulling rearward.



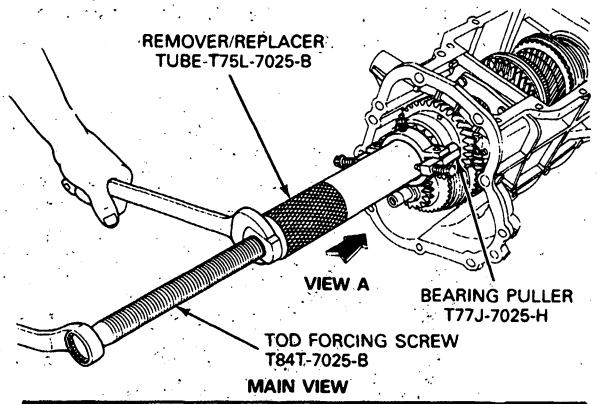


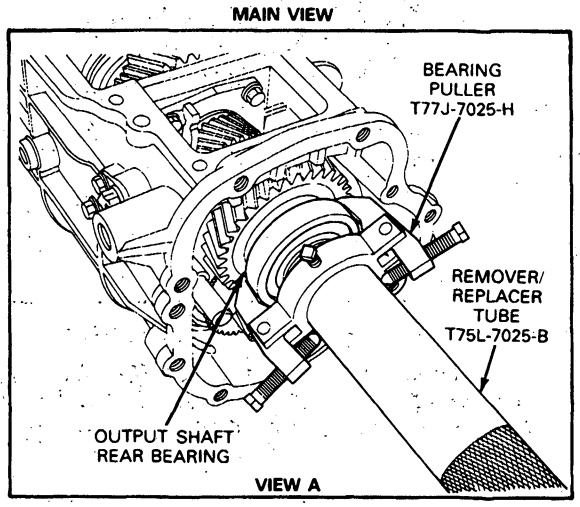
C6724-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

13. Remove output shaft rear bearing from output shaft using Remover/Replacer Tube T75L-7025-B, TOD Forcing Screw T84T-7025-B, Bearing Puller T77J-7025-H, and Puller Ring T77J-7025-J or equivalents.



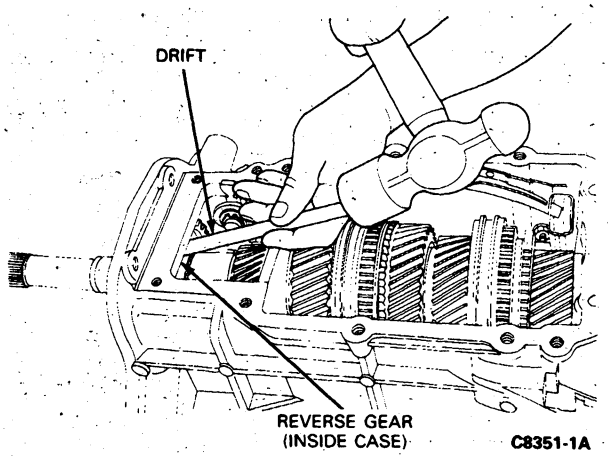


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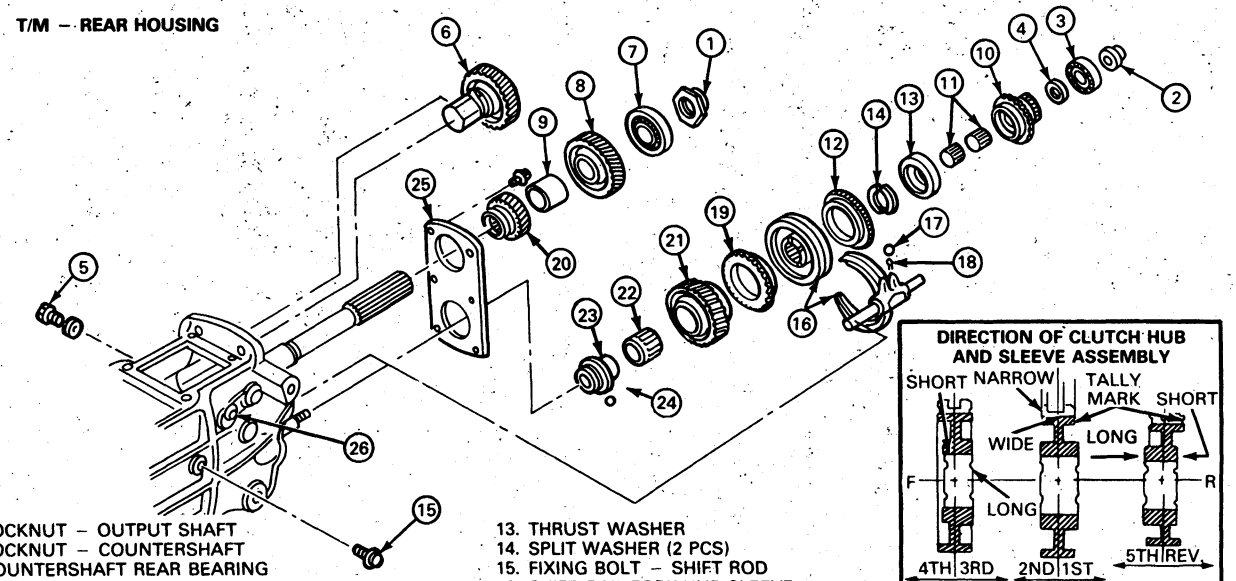
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DISASSEMBLY AND ASSEMBLY (Continued)

14. Using a brass drift and hammer, drive reverse gear from output shaft.



15. Remove sleeve from output shaft.
16. Remove counter reverse gear with two needle bearings and reverse synchronizer ring.



1. LOCKNUT – OUTPUT SHAFT
2. LOCKNUT – COUNTERSHAFT
3. COUNTERSHAFT REAR BEARING
4. THRUST WASHER
5. FIXING BOLT – REVERSE IDLER GEAR
6. REVERSE IDLE GEAR ASSEMBLY
7. BEARING – OUTPUT SHAFT REAR
8. REVERSE GEAR – OUTPUT SHAFT
9. SLEEVE – OUTPUT SHAFT
10. COUNTERSHAFT REVERSE GEAR
11. NEEDLE BEARINGS
12. SYNCHRONIZER RING – REVERSE
13. THRUST WASHER
14. SPLIT WASHER (2 PCS)
15. FIXING BOLT – SHIFT ROD
16. SHIFT RAIL/FORK/HUB/SLEEVE ASSEMBLY
17. LOCK BALL (STEEL) SHIFT RAIL
18. SPRING – SHIFT RAIL
19. SYNCHRONIZER RING – 5TH GEAR
20. 5TH GEAR – OUTPUT SHAFT
21. 5TH GEAR – COUNTERSHAFT
22. NEEDLE BEARING – 5TH GEAR
23. SLEEVE – 5TH GEAR
24. BALL
25. CENTER BEARING COVER
26. 5TH/REVERSE COUNTER LEVER LOCKPLATE RETAINING BOLT

C8352-2B

17. Remove thrust washer and split washer from countershaft.
18. Using a 12mm wrench, remove fifth/reverse shift rod fixing bolt.
19. Remove the following parts as an assembly:
    - Fifth/reverse synchronizer hub and sleeve assembly (countershaft)
    - Fifth/reverse shift fork and rod

NOTE: Do not separate steel ball and spring (removed from shift fork groove) unless necessary.

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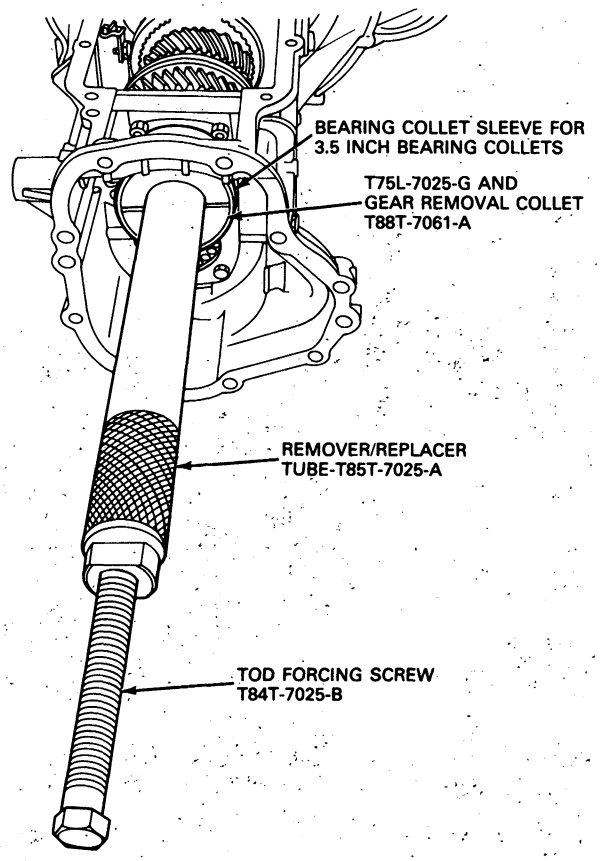
DISASSEMBLY AND ASSEMBLY (Continued)

20. Remove fifth gear synchronizer ring.
21. Remove the fifth/reverse counter lever lockplate retaining bolt and inner circlip. Remove counter lever assembly from transmission case.

NOTE: Do not remove the Torx® nut retaining the counter lever pin at this time.

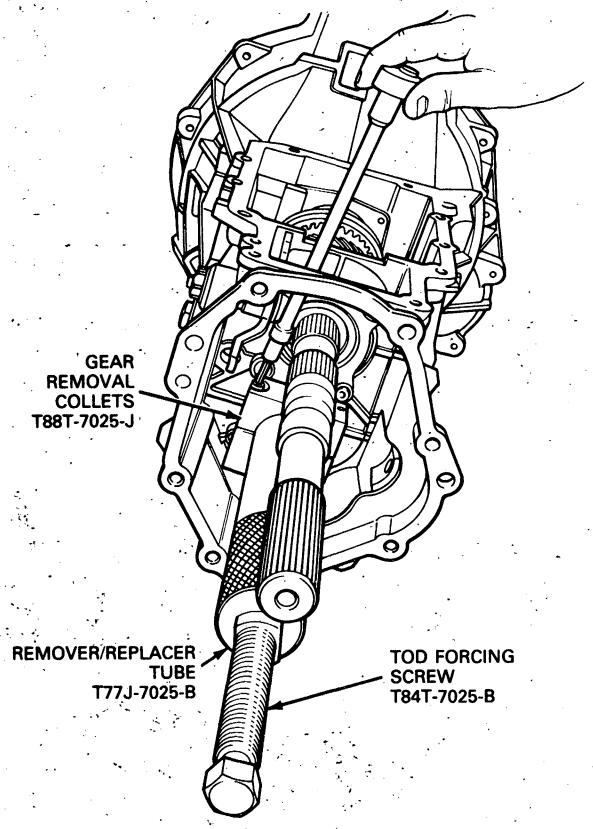
22. Remove fifth gear (counter) with needle bearing.
23. Remove fifth gear from output shaft using Bearing Collet Sleeve for 3.5-inch Bearing Collets T75L-7025-G, Remover/Replacer Tube T85T-7025-A, TOD Forcing Screw T84T-7025-B and Gear Removal Collet T88T-7061-A or equivalents.

NOTE: For reference during assembly, observe that the longer of the two collars on fifth gear faces forward.



C8673-1A

24. Remove fifth gear sleeve and (positioning) Ball using TOD Forcing Screw T84T-7025-B, Countershaft Fifth Gear Sleeve Puller T88T-7025-J, Gear Removal Collets T88T-7025-J1, and Remover/Replacer Tube T77J-7025-B, or equivalents.



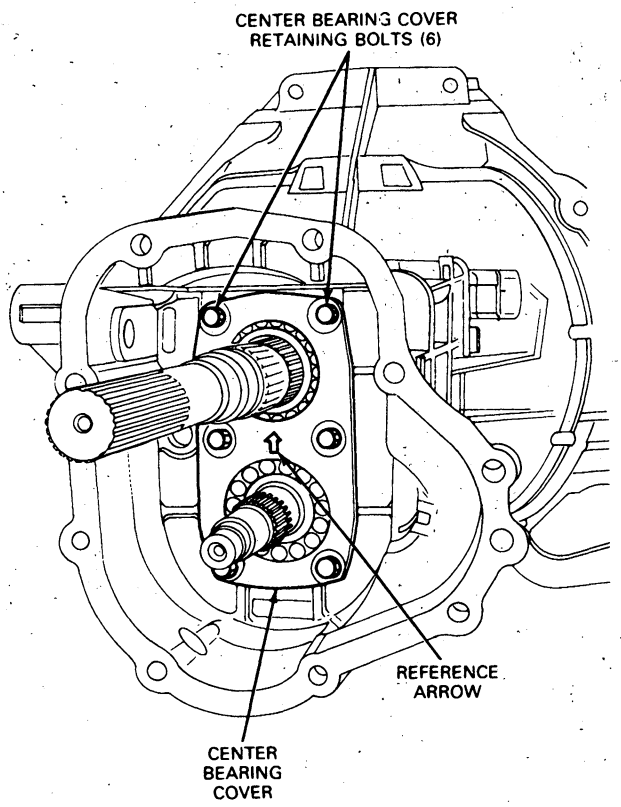
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DISASSEMBLY AND ASSEMBLY (Continued)

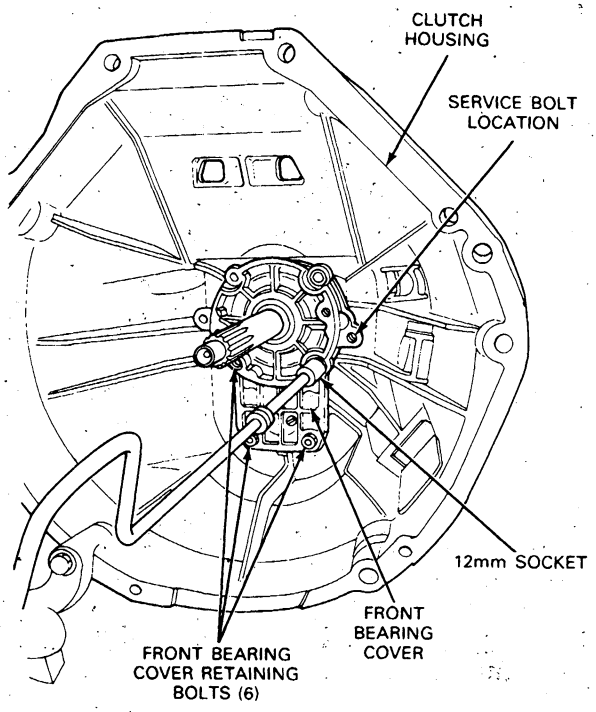
25. Using a 12mm socket, remove six center bearing cover retaining bolts. Remove center bearing cover.

NOTE: For reference during assembly, observe that reference arrow in middle of center bearing cover points upward. Observe that flanged side of center bearing cover faces inward.



C8354-1B

26. Using a 12mm socket, remove six front bearing cover attaching bolts.



C8355-1A

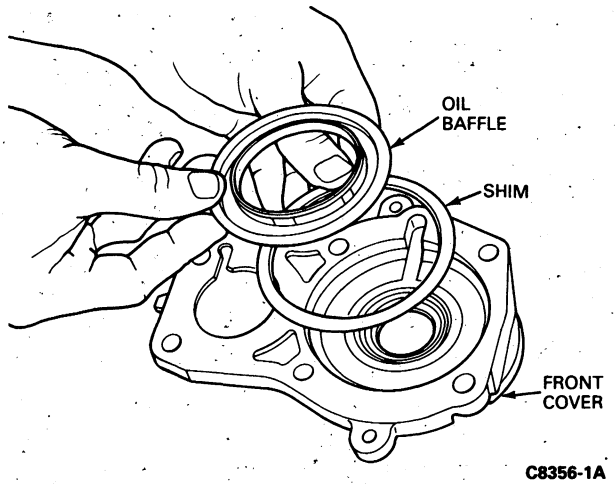
27. Remove front bearing cover by threading two of the originally installed retaining bolts into the front bearing cover service bolt locations (nine o'clock and three o'clock). Alternately tighten bolts until front bearing cover can be lifted away by hand. Remove and discard front bearing cover oil baffle.

NOTE: Bolts threaded into service bolt locations will bottom out and lift front bearing cover away from transmission case.

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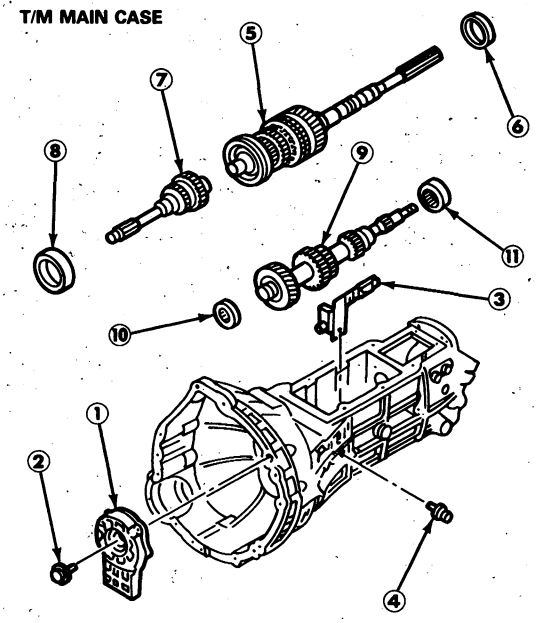
DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Do not remove plastic scoop ring from input shaft at this time.



C8356-1A

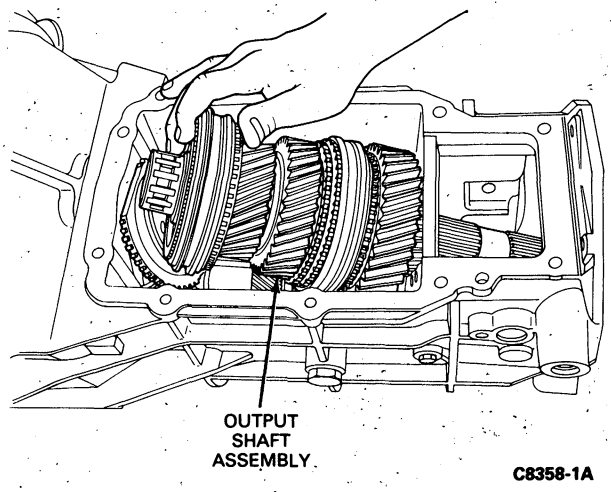
28. Using a 10mm socket, remove oil trough retaining bolt and oil trough from upper transmission case.



1. FRONT BEARING COVER
2. FRONT COVER RETAINING BOLT
3. OIL TROUGH
4. RETAINING BOLT – OIL TROUGH
5. OUTPUT SHAFT ASSEMBLY
6. OUTPUT SHAFT CENTER BEARING OUTER RACE
7. INPUT SHAFT ASSEMBLY
8. INPUT SHAFT BEARING OUTER RACE
9. COUNTER SHAFT ASSEMBLY
10. COUNTERSHAFT FRONT BEARING OUTER RACE
11. CONTERSHAFT REAR BEARING OUTER RACE

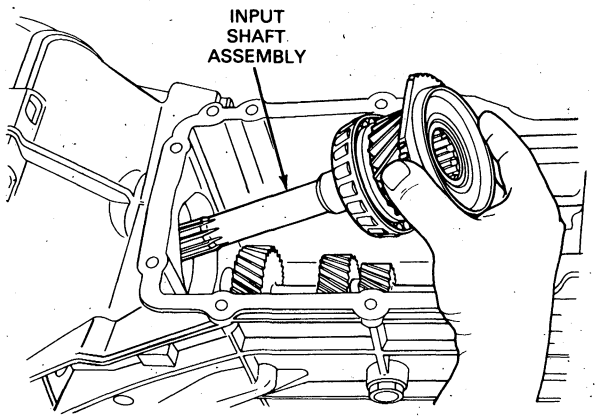
C8357-1A

29. Pull input shaft forward and remove input bearing outer race. Pull output shaft rearward.
30. Pull input shaft forward and separate it from output shaft. Incline output shaft upward and lift it from transmission case.



C8358-1A

31. Remove input shaft from transmission case.



C8359-1A

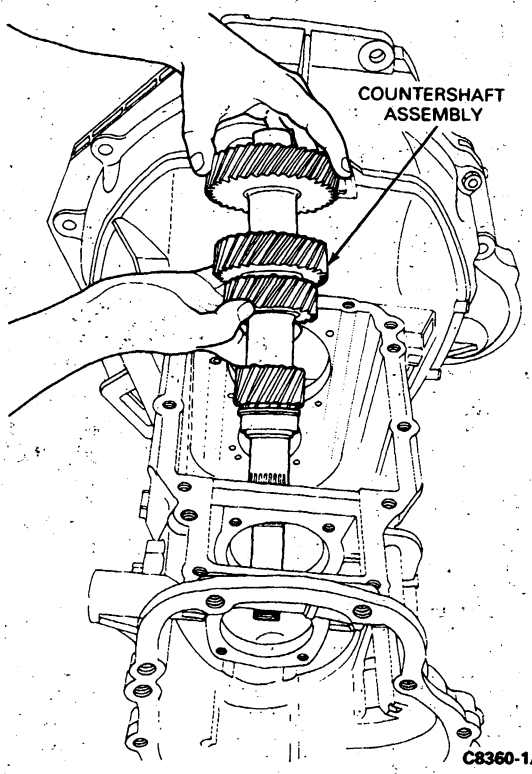
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DISASSEMBLY AND ASSEMBLY (Continued)

32. Remove countershaft bearing outer races (front and center) by moving countershaft forward and rearward. Pull countershaft rearward far enough to permit tool clearance behind front countershaft bearing. Using Bearing Race Puller T88T-7120-A and Slide Hammer T50T-100-A or equivalents, remove front countershaft bearing.

CAUTION: Tap gently during bearing removal. A forceful blow can cause damage to bearing or transmission case.

33. Remove countershaft through upper opening of transmission case.

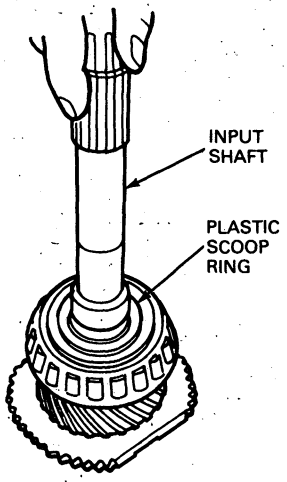


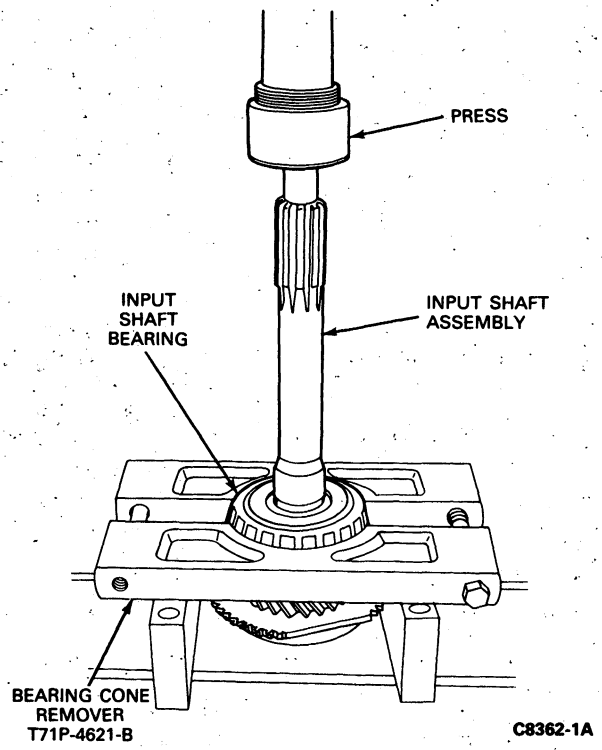
SUBASSEMBLIES

Input Shaft

Disassembly

1. Remove and discard plastic scoop ring.
2. Press tapered roller bearing from input shaft using Bearing Cone Remover T71P-4621-B or equivalent, and arbor press.



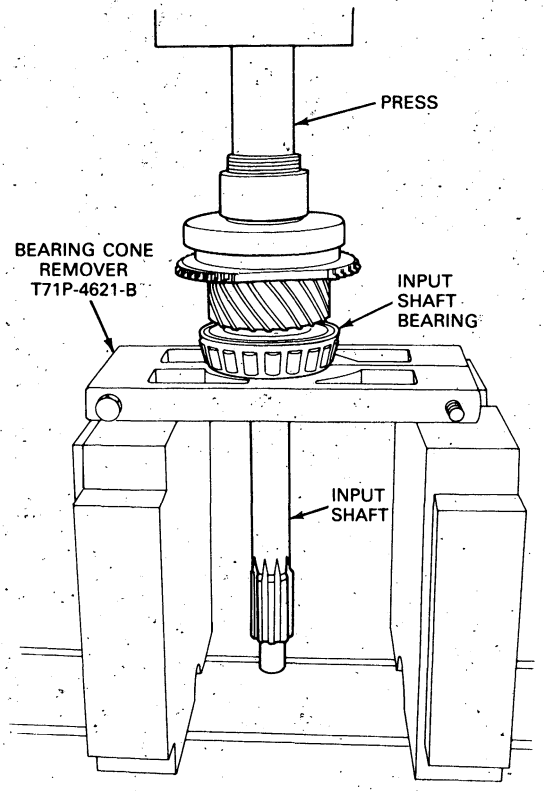


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SUBASSEMBLIES (Continued)

Assembly

1. Install input shaft tapered roller bearing onto input shaft using a press and Bearing Cone Replacer T88T-7025-B or equivalent.



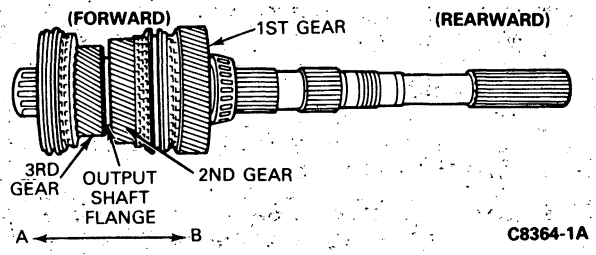
C8363-1A

2. Install plastic scoop ring onto input shaft. Manually rotate ring clockwise to ensure that input shaft oil holes properly engage scoop ring. A click should be heard as scoop ring notches align with input shaft oil holes.

Output Shaft

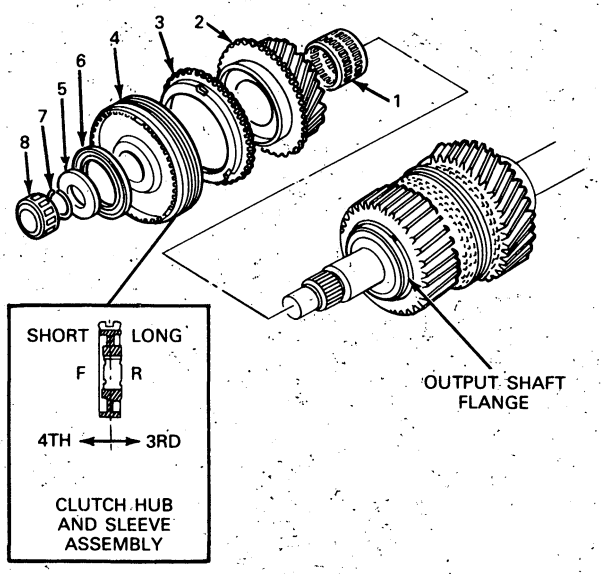
Disassembly

1. Position output shaft front flange as illustrated. Use this flange as a reference point and dividing line during assembly and disassembly procedures.



C8364-1A

2. Remove pilot bearing (needle roller), snap ring, needle bearing, and spacer from front (short side of flange) of output shaft.



1. NEEDLE BEARING – 3RD GEAR
2. THIRD GEAR
3. SYNCHRONIZER RING – 3RD GEAR
4. CLUTCH HUB AND SLEEVE ASSEMBLY – 3RD/4TH
5. SPACER
6. NEEDLE BEARING (PLAIN)
7. RETAINING RING
8. ROLLER BEARING – PILOT BEARING

C8365-1A

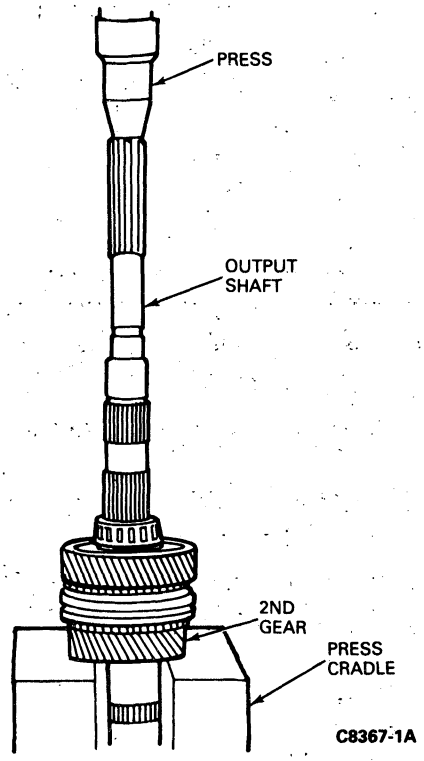
3. Position the front (short side of flange) of output shaft so that it faces upward. Lift off the following components as a unit:
   - Clutch hub and sleeve assembly (third/fourth).
   - Synchronizer ring (third).
   - Third gear.
   - Needle bearing.

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SUBASSEMBLIES (Continued)

4. Position output shaft with rear end (long side of flange) facing upward. Position output shaft into press with press cradle contacting lower part of second gear.

NOTE: Ensure that output shaft flange does not contact or ride up onto press cradle. Improper positioning of output shaft can cause component damage.

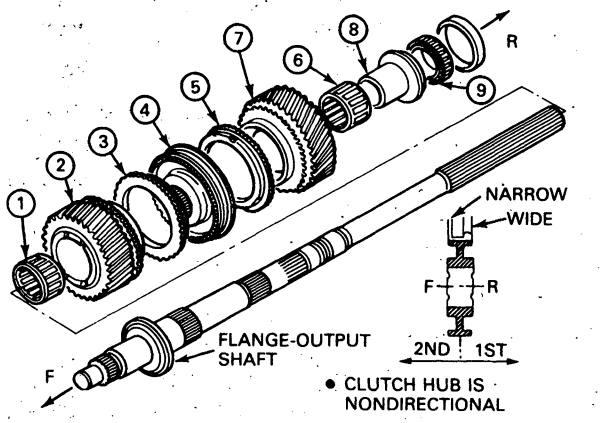


5. Press off the following components as a unit: Center bearing, first gear sleeve, first gear, needle bearing, first/second clutch hub and sleeve assembly, first/second synchronizer rings, second gear, and needle bearing using Bearing Replacer T53T-4621-B and Bearing Cone Replacer T88T-7025-B or equivalents. (Use T53T-4621-B as a press plate, and Bearing Cone Replacer T88T-7025-B to protect inner race rollers.)

Assembly

1. Position output shaft so that the rear end (long side of flange) faces upward. Install the following parts in the order listed.
   - Second gear needle bearing
   - Second gear
   - Second gear synchronizer ring
   - First/second clutch hub and sleeve assembly
   - First gear synchronizer ring
   - First gear needle bearing
   - First gear
   - First gear sleeve
   - Center bearing (inner)

NOTE: To install components onto output shaft, position components as shown. Press components into position using Bearing Replacer T53T-4621-B and Bearing Plate T75L-1165-B or equivalents.



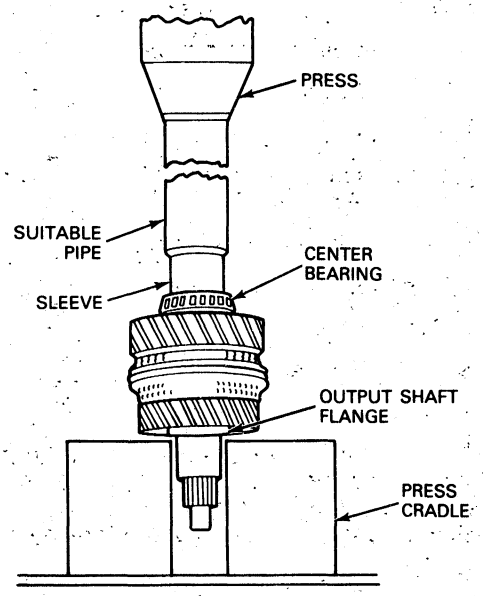
NOTE: Ensure that center bearing race is installed into transmission case.

NOTE: When installing first/second clutch hub and sleeve, ensure that smaller width of sleeve faces second gear (front) side. Ensure that reference marks face rear of transmission; they reference synchronizer key installation position.

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SUBASSEMBLIES (Continued)

2. Install center bearing to output shaft.

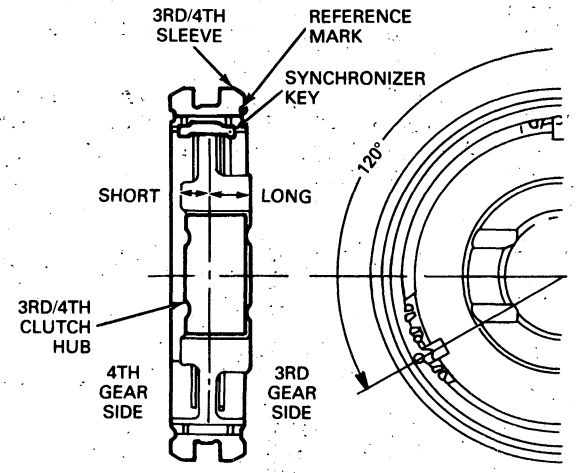


C8368-1A

3. Position output shaft so that front (short side) of output shaft flange faces upward. Install the following parts in the order listed.
   - Third gear needle bearing
   - Third gear
   - Third gear synchronizer ring

4. Install third/fourth clutch hub and sleeve as follows:
   - Mate clutch hub synchronizer key groove with reference mark on the clutch hub sleeve. The mark should face rearward.
   - Install longer flange on clutch hub sleeve toward third gear (rear) side.

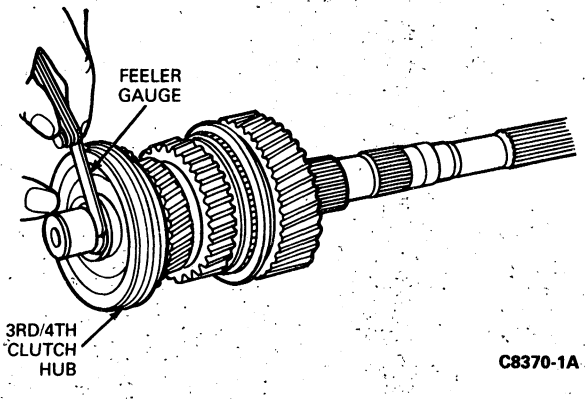
NOTE: The front and rear sides of the clutch hub are the same except for the reference mark on one side.



C8369-1A

5. Install the following parts in the order listed.
   - Spacer
   - Needle bearing—install with rollers upward (visible)
   - Retaining ring
   - Pilot bearing (roller)

6. Install original retaining ring. Check clutch hub end play using a feeler gauge.



C8370-1A

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SUBASSEMBLIES (Continued)

7. If necessary, adjust third/fourth clutch hub end play to 0.00-0.05mm (0.00-0.0019 inch) by selecting required retaining ring according to the chart. Install a new retaining ring if necessary.

NOTE: During installation, apply Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX, E4AZ-19582-B (ESP-M2C138-CJ) or equivalent to all rotating or sliding parts.

RETAINING RING SELECT CHART

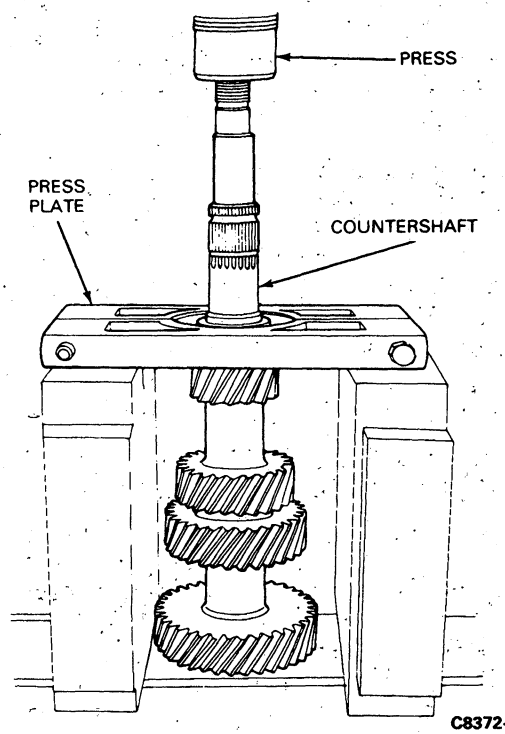
Part Number	Thickness	Part Number	Thickness
E8TZ-7030-A	1.50mm (0.059 in.)	E8TZ-7030-F	1.75mm (0.0688 in.)
E8TZ-7030-B	1.55mm (0.061 in.)	E8TZ-7030-G	1.80mm (0.0708 in.)
E8TZ-7030-C	1.60mm (0.0629 in.)	E8TZ-7030-H	1.85mm (0.0728 in.)
E8TZ-7030-D	1.65mm (0.0649 in.)	E8TZ-7030-J	1.90mm (0.0748 in.)
E8TZ-7030-E	1.70mm (0.0669 in.)	E8TZ-7030-K	1.95mm (0.0767 in.)

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Countershaft

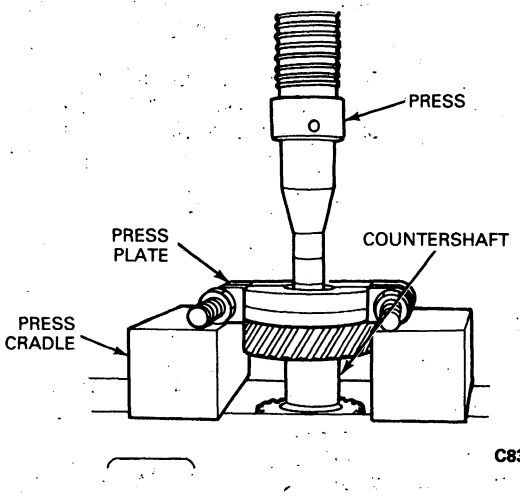
Disassembly

1. Using a press and Bearing Cone Remover T71P-4621-B or equivalent, remove the countershaft center bearing inner race.



C8372-1A

2. Using a press and Bearing Splitter D84L-1123-A or equivalent, remove the countershaft front bearing inner race.



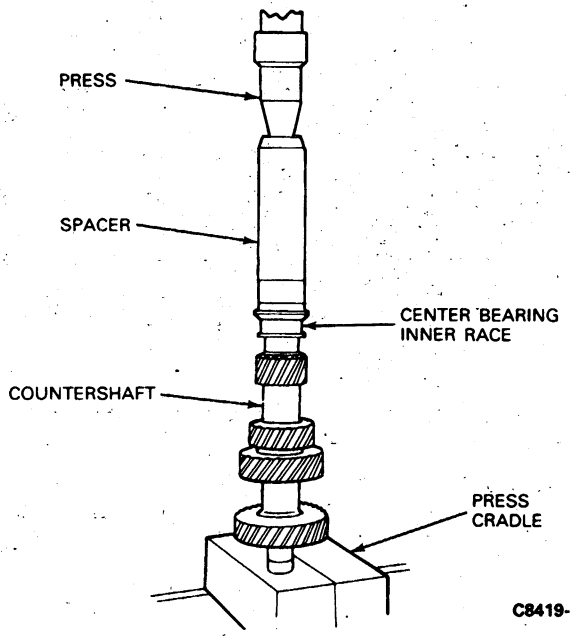
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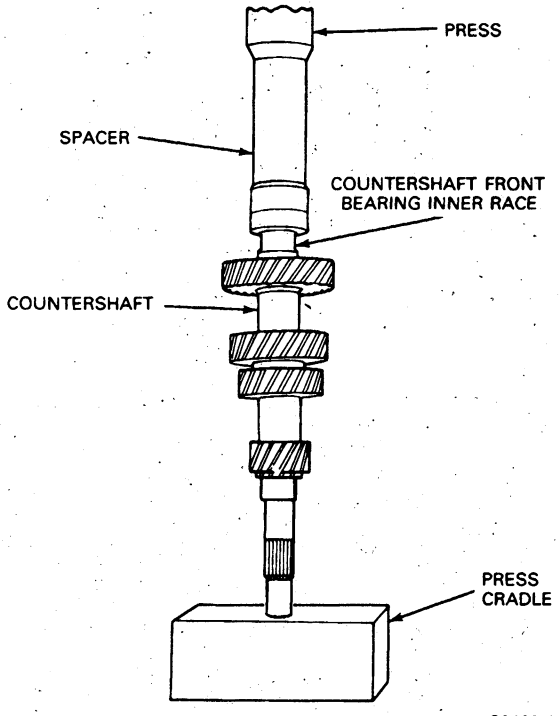
SUBASSEMBLIES (Continued)

Assembly

1. Using a press, a suitable press plate, and Bearing Replacer T53T-4621-B or equivalent, install center bearing inner race.



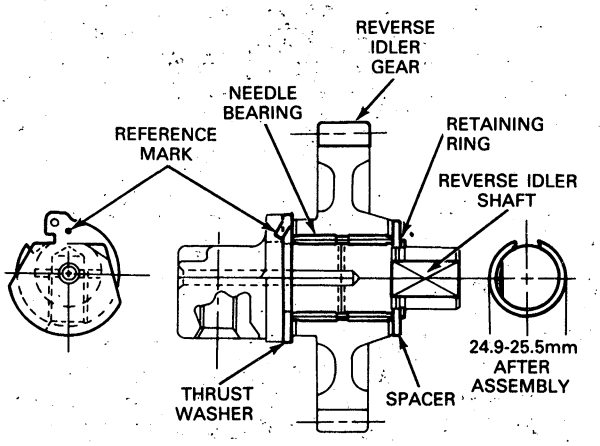
2. Using a press, a suitable press plate and Bearing Replacer T53T-4621-B or equivalent, install countershaft front bearing inner race.



Reverse Idler Gear Shaft

Disassembly

1. Remove the following parts from reverse idler gear shaft:
   - Retaining ring
   - Spacer
   - Idler gear
   - Needle bearings
   - Thrust washer



Assembly

1. Install thrust washer onto reverse idler gear shaft. Ensure that tab on thrust washer mates with groove on reverse idler shaft to prevent rotation of thrust washer.
2. Install the following parts onto reverse idler gear shaft in the order listed.
   - Needle bearings
   - Idler gear
   - Spacer
3. Install original retaining ring onto reverse idler gear shaft. Insert a feeler gauge between retaining ring and reverse idler gear to measure reverse idler gear end play. Using the chart, adjust reverse idler gear end play to 0.1-0.2mm (0.0039-0.0078 inch) by installing a retaining ring of necessary thickness.

REVERSE IDLER GEAR RETAINING RINGS

Part Number	Thickness
E8TZ-7156-F	1.5mm (0.059 in.)
E8TZ-7156-E	1.6mm (0.0629 in.)
E8TZ-7156-D	1.7mm (0.0669 in.)
E8TZ-7156-C	1.8mm (0.0708 in.)
E8TZ-7156-B	1.9mm (0.0748 in.)

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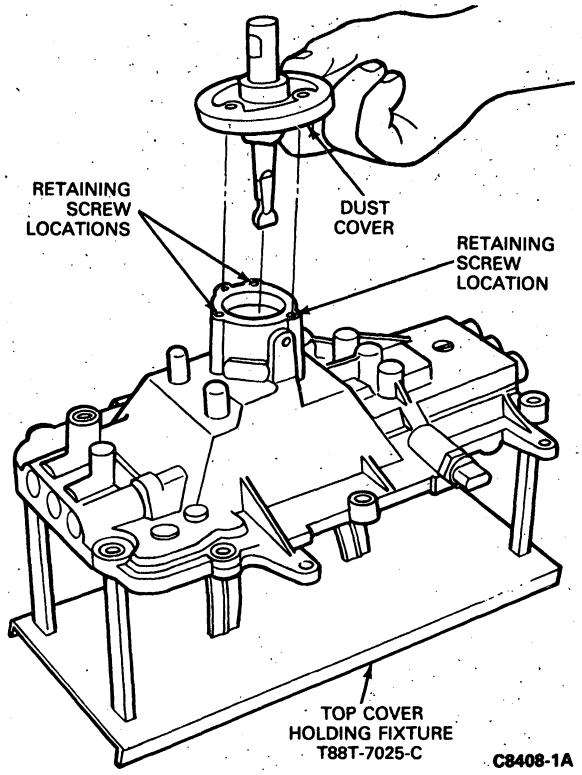
SUBASSEMBLIES (Continued)

Top Cover

Disassembly

1. If necessary, remove dust boot and shift lever from top cover. Remove three dust cover retaining screws using a 4mm Allen wrench. Remove dust cover.

NOTE: For reference during assembly, notice that grooves in bushing align with slots in lower shift lever pivot ball. Notice that the notch in the lower shift lever faces toward front of transmission.



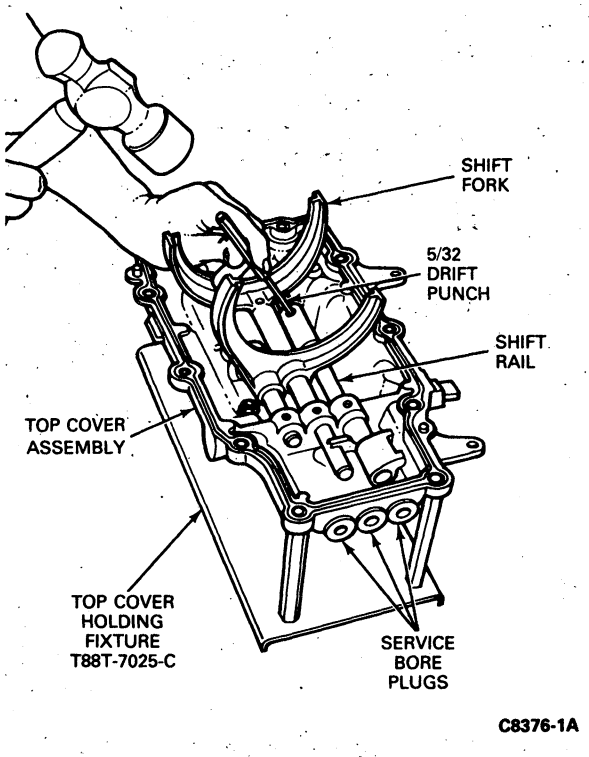
2. Position top cover assembly into Top Cover Holding Fixture T88T-7025-C or equivalent.

3. Remove backup lamp switch from top cover. Remove backup lamp switch pin from groove in top cover.

NOTE: Only one type of backup lamp switch pin is used.

4. Using a 5/32-inch drift punch, remove spring pins retaining shift forks to shift rails.

NOTE: Discard original spring pins.



5. Ensure that fifth/reverse shift rail is in fully forward position. Remove spring pin from end of fifth/reverse rail.

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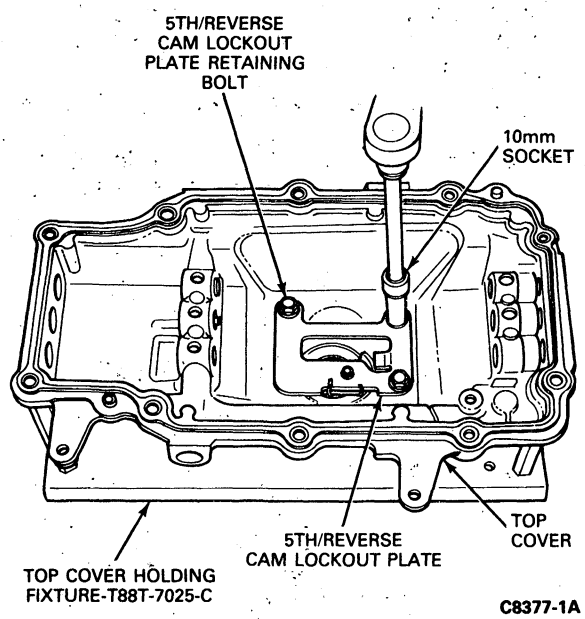
SUBASSEMBLIES (Continued)

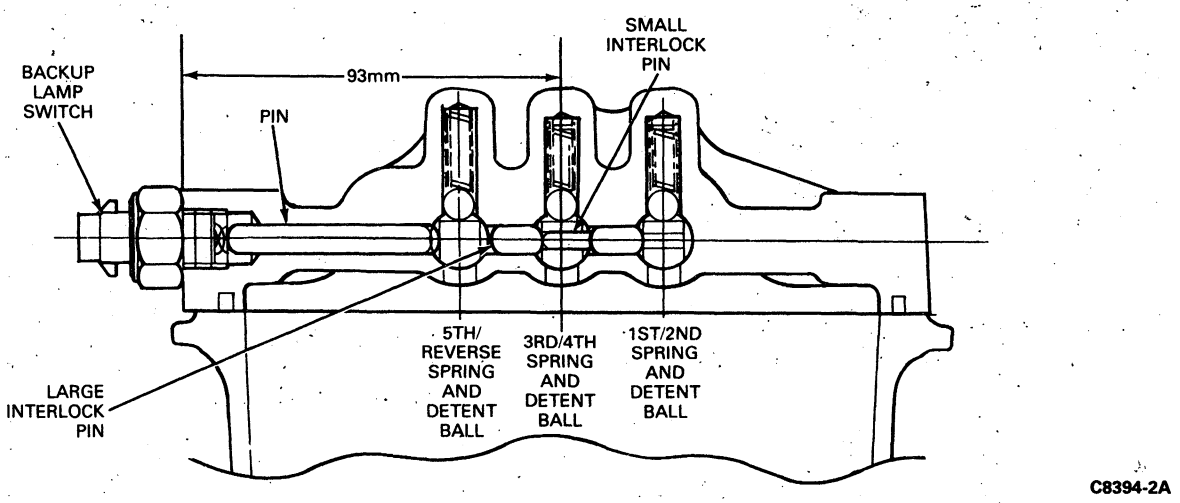
6. Remove three rubber plugs blocking shift rod service bores.

CAUTION: Perform the following shift rail removal procedures with great care. Cover the lock ball bores and friction device and spring seats with a clean cloth held firmly in place during shift rail removal. Failure to firmly cover lock ball bores and friction device can result in component loss when the ball/friction device and spring forcefully leave their installed positions.

WARNING: WEAR SAFETY GLASSES WHILE PERFORMING SHIFT RAIL REMOVAL PROCEDURE.

7. Remove fifth/reverse shift rail from top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
8. Remove first/second shift rail from top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
9. Remove third/fourth shift rail from top cover through service bore. If necessary, insert a drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
10. Remove fifth/reverse cam lockout plate retaining bolts using a 10mm socket. Remove fifth/reverse cam lockout plate.





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SUBASSEMBLIES (Continued)

Assembly

1. Position top cover into Top Cover Holding Fixture T88T-7025-C or equivalent.
2. Position fifth/reverse cam lockout plate to top cover. Install fifth/reverse cam lockout plate retaining bolts and tighten to 8-10-N·m (6-7 ft-lb).
3. Position third/fourth shift rail into top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining forward pressure. Engage third/fourth shift fork with shift rail. Position detent ball and spring into top cover spring seats. Compress the detent ball and spring assembly using a suitable tool, and push shift rail into position over detent ball. Position friction device and spring into top cover spring seats. Compress friction device and spring assembly using a suitable tool, and push shift rail into position over friction device. Install spring pins retaining shift rail to top cover. Install spring retaining third/fourth shift fork to shift rail.
4. Position first/second shift rail into top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining forward pressure. Engage first/second shift fork with shift rail. Position detent ball and spring into top cover spring seats. Compress the detent ball and spring assembly using a suitable tool and push shift rail into position over detent ball. Position friction device and spring into top cover spring seats. Compress friction device and spring assembly using a suitable tool, and push shift rail into position over friction device. Install spring pins retaining shift rail to top cover. Install spring pin retaining first/second shift fork to shift rail.
5. Position fifth/reverse shift rail to top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock from side to side while maintaining forward pressure. Engage fifth/reverse shift fork with shift rail. Position detent ball and spring into spring seats. Compress the detent ball and spring using a suitable tool, and push shift rail into position over detent ball. Install spring pins retaining shift rail to top cover. Install spring pin retaining fifth/reverse shift fork to shift rail.
6. Install rubber plugs into service bores.
7. Install interlock pins into first/second and third/fourth shift rails. Ensure that large and small interlock pins are installed into their original positions.

NOTE: Improper installation of interlock pins will prevent activation of neutral switch and/or backup lamp switch.

8. Apply sealant to backup lamp switch and neutral switch threads. Install switches to top cover and tighten to 25-35 N·m (18-26 ft-lb).
9. Position lower shift lever and dust cover assembly to top cover. Install three retaining screws and tighten to specification.

CLEANING AND INSPECTION

Cleaning

1. Wash all parts, except ball bearings and seals, in a suitable cleaning solvent. Brush or scrape all foreign matter from the parts. Be careful not to damage any parts with the scraper. Do not clean, wash, or soak transmission seals in cleaning solvent. Dry all parts with compressed air.
2. Rotate the bearings in a cleaning solvent until all lubricant is removed. Hold the bearing assembly to prevent it from rotating while drying it with compressed air.
3. Lubricate the bearings with approved transmission lubricant. Wrap them in a clean, lint-free cloth or paper, until ready for use.

General Inspection

1. Inspect transmission case and housing for cracks, worn or damaged bores, damaged threads, or any other damage that could affect operation of the transmission. Inspect the machined mating surfaces for burrs, nicks or damage.
2. Inspect the front face of case for small nicks or burrs that could cause misalignment of transmission with flywheel housing. Remove all small nicks or burrs with a fine stone.
3. Inspect bell housing for cracks. Make sure the machined mating surfaces are free from burrs, nicks, or any other damage.
4. Check the condition of shift levers, forks, shift rails and shafts.
5. Inspect ball bearings. Refer to Ball Bearing Inspection.

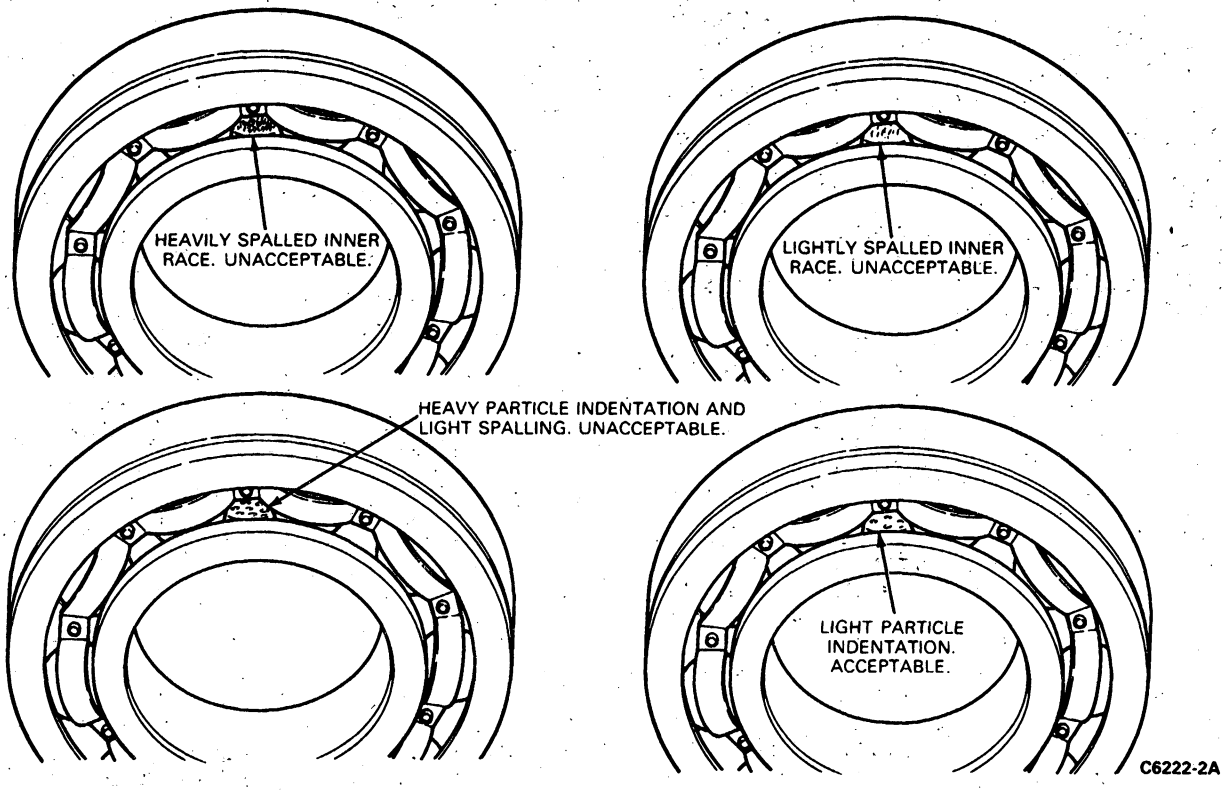
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CLEANING AND INSPECTION (Continued)

Ball Bearing Inspection

Bearing Raceways

1. Inner Ring Raceway—While holding outer ring stationary, rotate inner ring at least three revolutions. Examine raceway of inner ring for pits or spalling. If pits or spalling are unacceptable, replace the bearing assembly. Light particle indentation is acceptable.
2. Outer Ring Raceway—While holding inner ring stationary, rotate outer ring at least three revolutions. Examine raceway of the outer ring from the same side as the raceway of the inner ring. If raceway is spalled or pitted, similar to that shown, replace the bearing assembly. Light particle indentation is acceptable.



Bearing External Surfaces

The bearing must be replaced if damage is found in any of the following areas:

1. Radial cracks on front and rear faces of outer or inner rings.
2. Cracks on outside diameter or outer ring (particularly around snap ring groove).
3. Deformation or cracks in ball cage (particularly around rivets).

Spin Test

1. Lubricate bearing raceways with a slight amount of clean oil. Turn the bearing back and forth slowly until raceways and balls are coated with oil.
2. Hold bearing by inner ring in a vertical position. Vertical movement between the inner and outer rings in acceptable. Spin outer ring several times by hand (do not use an air hose). If roughness or vibration is noticeable or the outer ring stops abruptly, the bearing should be cleaned again and lubricated. Roughness in a bearing is usually caused by foreign particles in the bearing, which comes from inside the transmission case. If bearing is still rough after cleaning and relubricating three times, it must be replaced.
3. Hold bearing by the inner ring in a horizontal position with the snap ring groove up. Spin outer ring several times by hand (do not use an air hose). If bearing is still rough after cleaning and re-lubricating three times (if not done in Step 2), it must be replaced. If bearing passes the visual inspection and spin tests, it can be re-installed in transmission.

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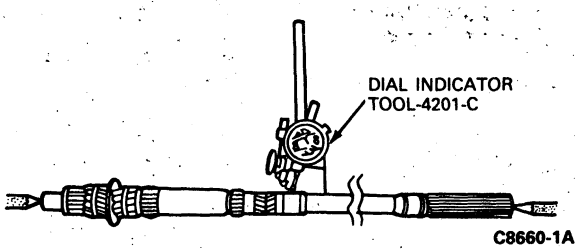
CLEANING AND INSPECTION (Continued)

Gear Inspection

Inspect the teeth of each gear. If excessively worn, broken or chipped, replace the gear. Excessive wear increases backlash, which results in noise and unacceptable operating characteristics.

Output Shaft Inspection

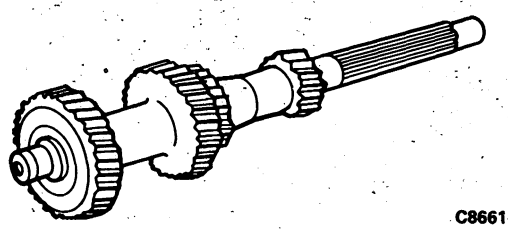
1. Check output shaft for run-out by mounting the shaft between V-blocks and applying dial indicator TOOL-4201-C or equivalent to several places along shaft. The standard reading of the indicator for run-out should be less than 0.05mm (0.002 in.). If run-out exceeds 0.05mm (0.002 in.), replace mainshaft.
2. Replace input shaft if spines are damaged. If needle bearing surface in bore of bearing is worn or rough, or if cone surface is damaged, replace shaft.



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Countershaft Inspection

Check countershaft gear teeth and countershaft splines for wear or damage. Replace countershaft if bent, scored, or worn.

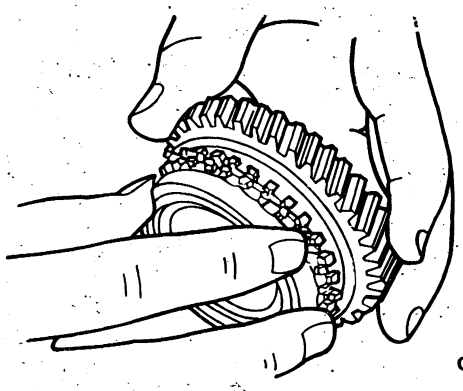

C8661-1A

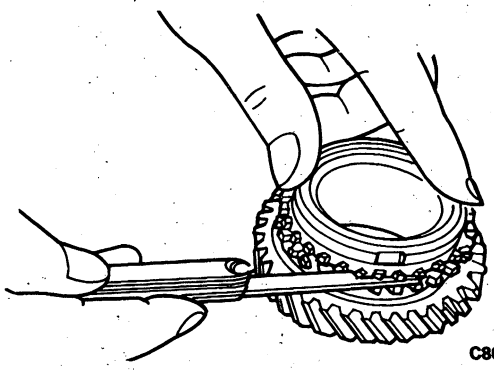
Synchronizer Mechanism Inspection

1. Inspect gear teeth on synchronizer ring. If there is evidence of chipping or excessively worn teeth, replace with new parts.
2. Inspect synchronizer ring for wear. To check the wear of synchronizer ring, fit synchronizer ring evenly to gear cone. Measure clearance between side faces of synchronizer ring and gear with a feeler gauge. If clearance is less than 0.8mm (0.031 in.), replace synchronizer ring or gear.

NOTE: First/second, third/fourth and fifth/reverse synchronizer-to-gear clearance specifications are the same.

3. Inspect contact between inner surface of synchronizer ring and cone surface of gear. To inspect, apply a thin coat of Prussian Blue or equivalent on cone surface of gear and fit in into the ring. If the contact pattern is poor, correct this by applying compound and lapping surfaces together.
4. Make sure clutch sleeve slides easily onto clutch hub.
5. Check synchronizer inserts (keys), inner surface of clutch sleeve, and insert groove on clutch hub for wear.
6. Check synchronizer insert spring for tension.


C8656-1A

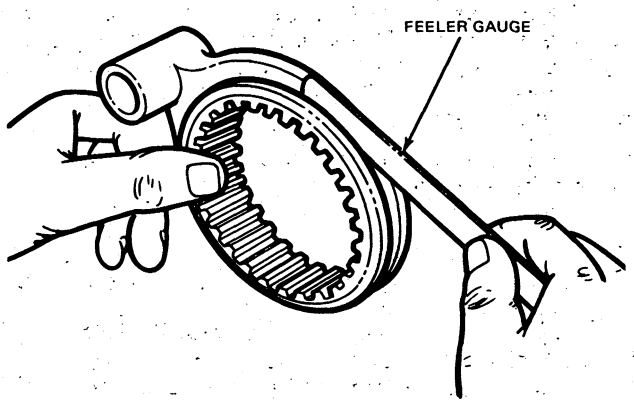

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CLEANING AND INSPECTION (Continued)

Shift Fork/Clutch Hub Sleeve Inspection

Check the contact surfaces of the shift fork and clutch hub sleeve for evidence of wear or damage. Measure from shift fork to the clutch hub sleeve. Clearance should not exceed 0.8mm (0.031 in.).



C3437-1A

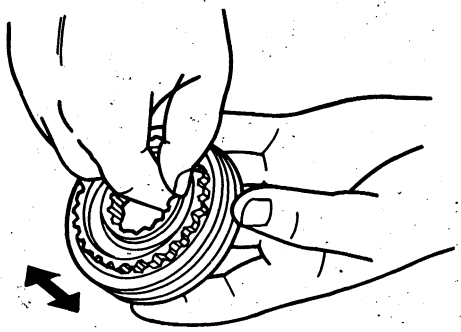
CLUTCH HUB SLEEVE-TO-SHIFT FORK CLEARANCE (R2)

Standard	Maximum
1st/2nd 0.1-0.358mm (0.003-0.014)	0.8mm (0.314 in.)
3rd/4th 0.1-0.358mm (0.003-0.014 in.)	0.8mm (0.314 in.)
5th/Rev 0.1-0.37mm (0.003-0.015 in.)	0.8mm (0.314 in.)

CC8662-1B

Clutch Hub Inspection

1. Check operation of clutch hub sleeve installed onto hub.
2. Position clutch hub and sleeve horizontally. Lift the hub approximately three-quarters of the way off the sleeve. Release the hub, and observe downward motion. Hub should slide downward into sleeve on its own. It should not be necessary to push hub into sleeve. Service as necessary.



C8658-1A

Extension Housing Inspection

Inspect the extension housing for cracks. Ensure that the machined mating surfaces are free from burrs, nicks, or any other damage. If necessary, replace the oil seal after the extension housing has been installed onto the transmission.

NOTE: The extension housing rear bushing cannot be serviced. If it requires service, the extension housing must be replaced as a unit.

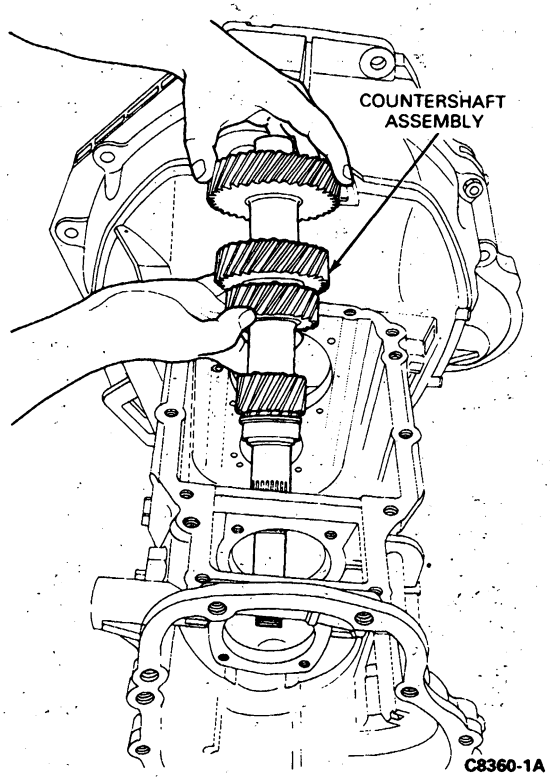
Speedometer Gears Inspection

Check the drive gear and driven gear, and the driven gear shaft for wear or damage. Check the O-ring and oil seal for weakness or damage.

Transmission

Assembly

1. Position countershaft into transmission case through top opening.



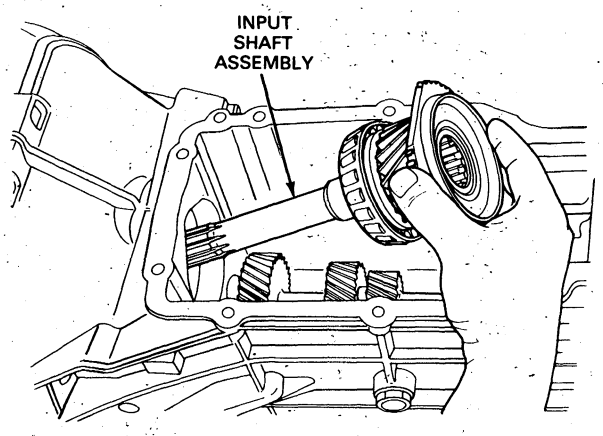
C8360-1A

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CLEANING AND INSPECTION (Continued)

2. Position input shaft into transmission case through top opening.

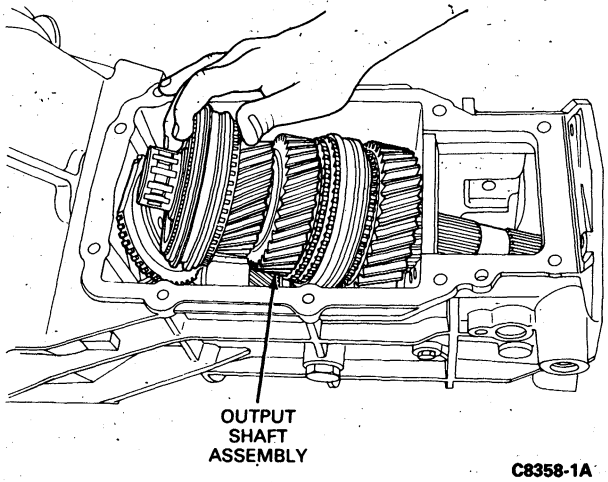
NOTE: Ensure that needle roller bearing is installed into input shaft.



C8359-1A

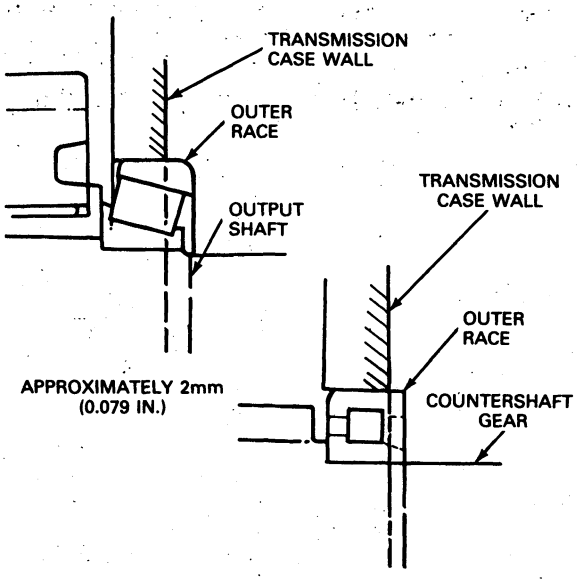
3. Position output shaft assembly into transmission case. Mate input and output shaft assemblies by positioning them at an upward angle and setting them together.

NOTE: Ensure that fourth gear synchronizer ring is installed at this time.

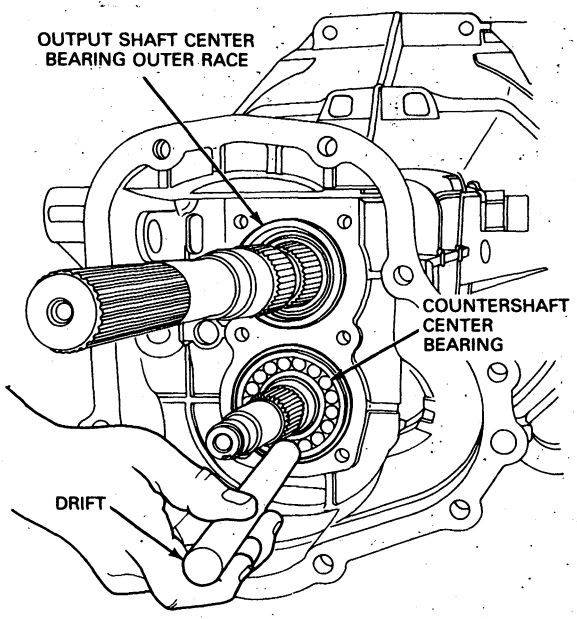


C8358-1A

4. Install output shaft center bearing outer race using a brass drift. Seat center bearing outer races, maintaining bearing position illustrated.



C8406-1B



C8380-1A

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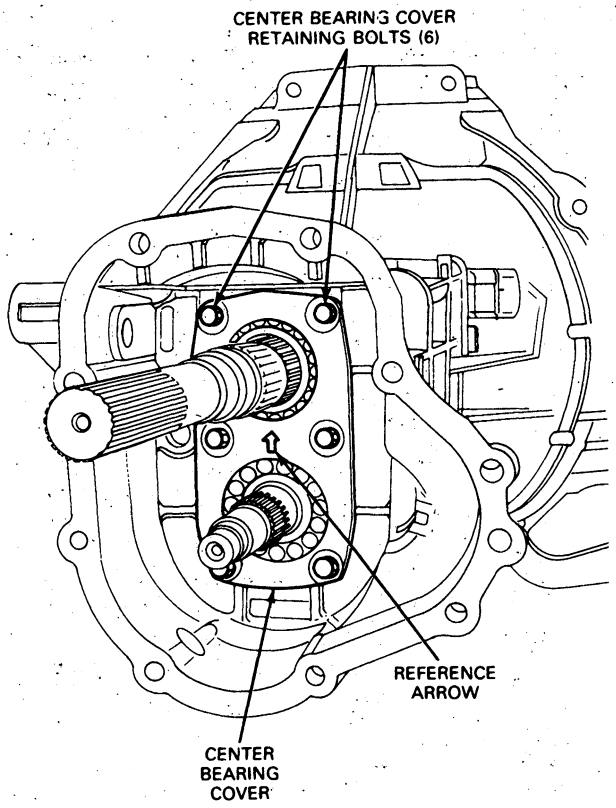
CLEANING AND INSPECTION (Continued)

5. Install countershaft center bearing (not race).

NOTE: Ensure that center bearing outer races are squarely positioned in bores.

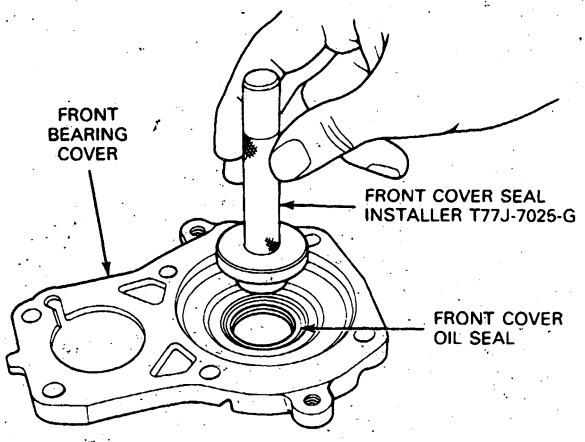
6. Position center bearing cover to transmission case with reference arrow pointing upward. Install and tighten center bearing cover retaining bolts to 18-26 N·m (14-19 ft-lb).

NOTE: Ensure that all center bearing cover retaining bolt heads are marked with an "8".



C8354-1B

7. Position transmission vertically (input shaft and clutch housing facing upward). Ensure that input shaft front bearing outer race is squarely positioned in bore. If removed, install front cover oil seal using Front Cover Seal Installer T77J-7025-G or equivalent.



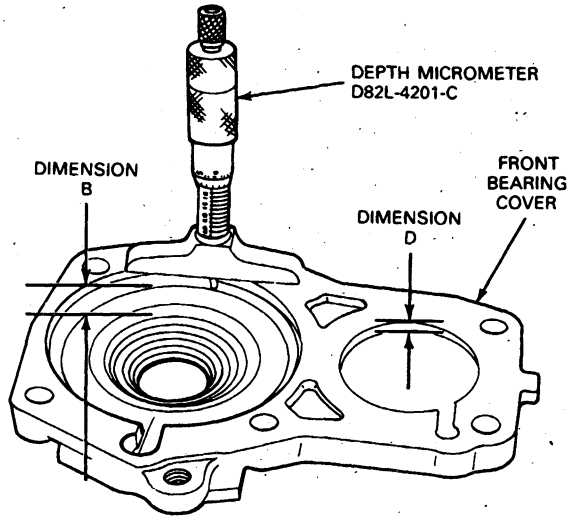
C8412-1A

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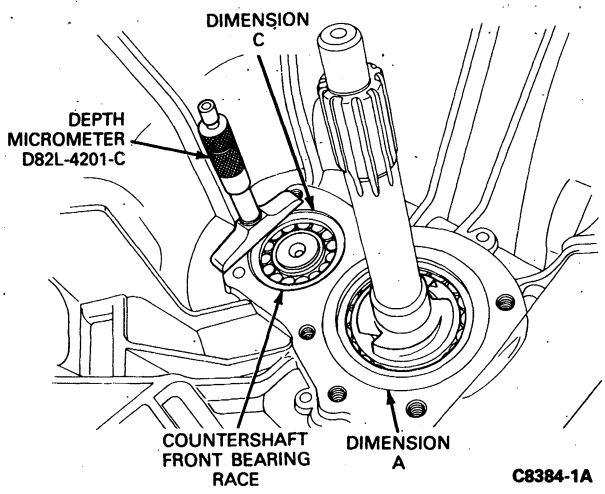
CLEANING AND INSPECTION (Continued)

8. Install countershaft front bearing by hand.

NOTE: If any related parts (such as output shaft, bearing, etc.) have been replaced, measure dimensions A, B, C, and D as illustrated. After measuring all dimensions, select bearing shim to maintain end play within specified limits.



C8383-1A

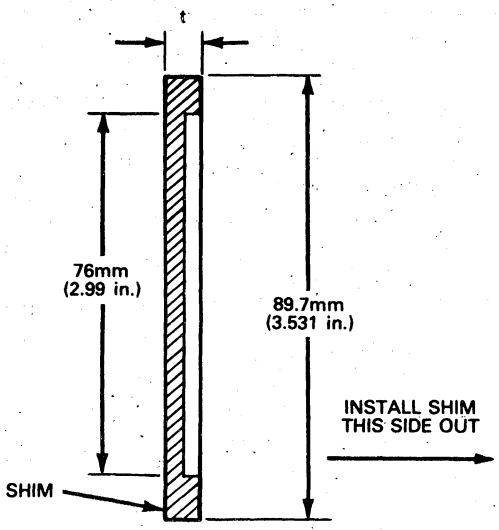


C8384-1A

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CLEANING AND INSPECTION (Continued)

- **Dimension A:** Height of input shaft bearing outer race above transmission front bearing cover mating surface.
- **Dimension B:** Depth of front cover outer race bore (input shaft).
- **Dimension C:** Depth of countershaft front bearing race (transmission case to front cover mating surface).
- **Dimension D:** Depth of front cover outer race bore (countershaft).



- Shim computation equations are as follows:

  Dimension B - (Dimension A + shim thickness) = 0.05 to 0.15mm (0.002 to 0.006 inch)

  Dimension C + (Dimension D - shim thickness) = 0.15 to 0.25mm (0.006 to 0.010 inch)

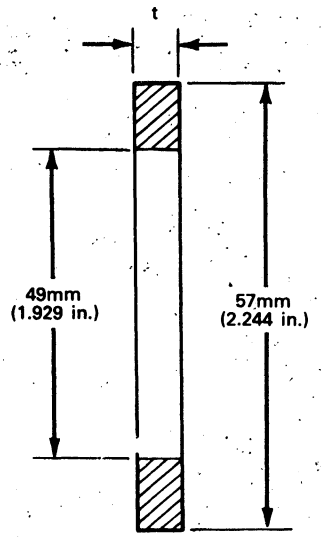
SHIM SELECT CHART — M50D R2

Part Number	Thickness (t)
E8TZ-7029-FA	1.4mm (0.0551 in.)
E8TZ-7029-GA	1.5mm (0.0590 in.)
E8TZ-7029-Ha	1.6mm (0.0629 in.)
E8TZ-7029-Ja	1.7mm (0.0669 in.)
E8TZ-7029-S	1.8mm (0.0708 in.)
E8TZ-7029-T	1.9mm (0.0748 in.)
E8TZ-7029-U	2.0mm (0.0787 in.)
E8TZ-7029-V	2.1mm (0.0826 in.)
E8TZ-7029-W	2.2mm (0.0866 in.)
E8TZ-7029-X	2.3mm (0.0905 in.)
E8TZ-7029-Y	2.4mm (0.0944 in.)
E8TZ-7029-Z	2.5mm (0.0984 in.)
E8TZ-7029-AA	2.6mm (0.1023 in.)
E8TZ-7029-BA	2.7mm (0.1062 in.)
E8TZ-7029-CA	2.8mm (0.1102 in.)
E8TZ-7029-DA	2.9mm (0.1141 in.)
E8TZ-7029-EA	3.0mm (0.1181 in.)

CC8395-2A

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CLEANING AND INSPECTION (Continued)



SPACER SELECT CHART — M50D-R2

Part Number	Thickness (t)
E8TZ-7C434-K	3.1mm (0.122 in.)
E8TZ-7C434-L	3.2mm (0.125 in.)
E8TZ-7C434-M	3.3mm (0.129 in.)
E8TZ-7C434-N	3.4mm (0.133 in.)
E8TZ-7C434-P	3.5mm (0.137 in.)
E8TZ-7C434-R	3.6mm (0.141 in.)
E8TZ-7C434-S	3.7mm (0.145 in.)
E8TZ-7C434-T	3.0mm (0.1181 in.)

CC8396-2A

9. Remove any sealant residue remaining on mating surfaces of transmission and front cover.

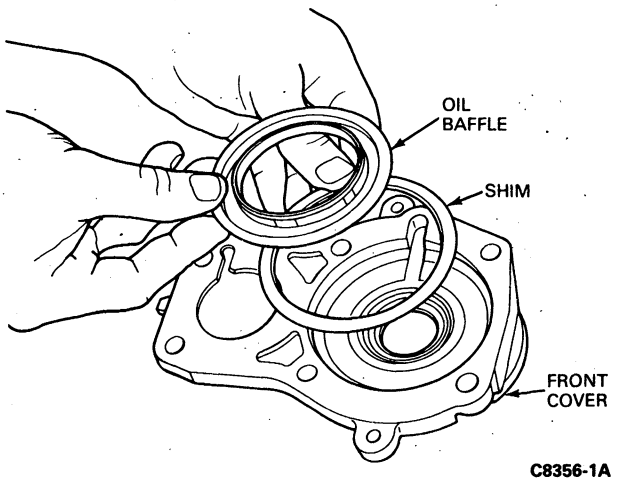
NOTE: To prevent damage to oil seal lip during assembly, tape the input shaft splines along their entire length.

10. Apply a thin coat of oil to front cover oil seal lip. Position bearing shim and baffle plate into front cover (install shim with groove showing). Install spacer to transmission case countershaft front bearing bore.

NOTE: If necessary, apply a sufficient quantity of grease to shim, bearing cover and oil baffle to retain them in position during assembly.

11. Apply a 1/8-inch bead of Silicone Rubber D6AZ-19562-BA or equivalent to front cover and front cover retaining bolt threads. Install front bearing cover to transmission case. Install and tighten front bearing cover retaining bolts to 12-22 N·m (9-17 ft-lb).

NOTE: Ensure that front bearing cover retaining bolt heads are marked with a "6".



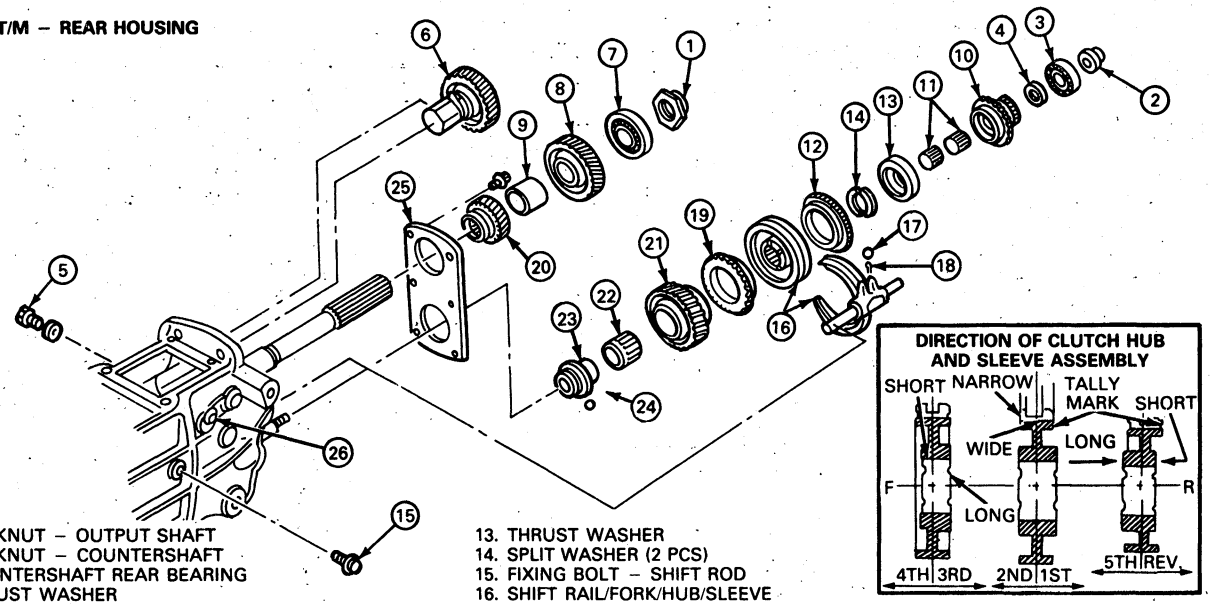
C8356-1A

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CLEANING AND INSPECTION (Continued)

12. Position transmission horizontally in holding fixture. Assemble the following parts in the order listed.
    - Ball
    - Fifth gear sleeve

NOTE: Install fifth gear sleeve using nut, Shaft Adapter-Replacing, T75L-7025-L, Adapter T88T-7025-J2, and Remover/Replacer Tube T75L-7025-B, or equivalents.



1. LOCKNUT – OUTPUT SHAFT
2. LOCKNUT – COUNTERSHAFT
3. COUNTERSHAFT REAR BEARING
4. THRUST WASHER
5. FIXING BOLT – REVERSE IDLER GEAR
6. REVERSE IDLE GEAR ASSEMBLY
7. BEARING – OUTPUT SHAFT REAR
8. REVERSE GEAR – OUTPUT SHAFT
9. SLEEVE – OUTPUT SHAFT
10. COUNTERSHAFT REVERSE GEAR
11. NEEDLE BEARINGS
12. SYNCHRONIZER RING – REVERSE
13. THRUST WASHER
14. SPLIT WASHER (2 PCS)
15. FIXING BOLT – SHIFT ROD
16. SHIFT RAIL/FORK/HUB/SLEEVE ASSEMBLY
17. LOCK BALL (STEEL)
    SHIFT RAIL
18. SPRING – SHIFT RAIL
19. SYNCHRONIZER RING – 5TH GEAR
20. 5TH GEAR – OUTPUT SHAFT
21. 5TH GEAR – COUNTERSHAFT
22. NEEDLE BEARING – 5TH GEAR
23. SLEEVE – 5TH GEAR
24. BALL
25. CENTER BEARING COVER
26. 5TH/REVERSE COUNTER LEVER LOCKPLATE RETAINING BOLT

C8352-2B

13. Install fifth gear needle bearing onto fifth gear (countershaft).

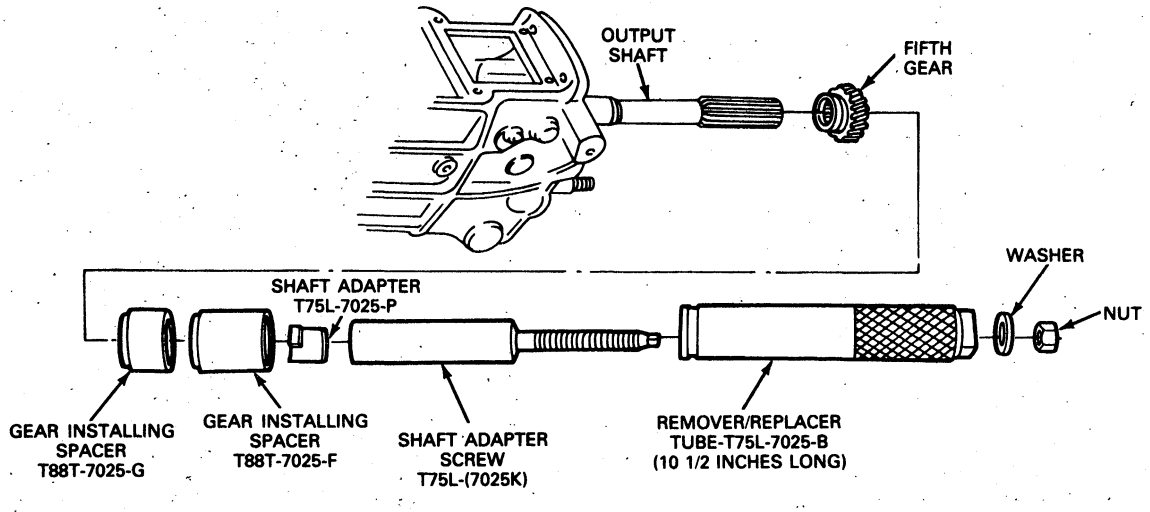
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CLEANING AND INSPECTION (Continued)

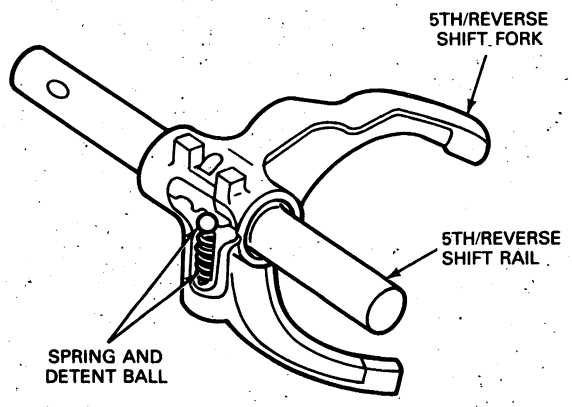
14. Install fifth gear onto output shaft using Gear Installing Spacer T88T-7025-F, Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover/Replacer Tube T75L-7025-B (4 x 2 models only), or Remover/Replacer Tube T85T-7025-A (4 x 4 models only) nut, and washer, or equivalents. Ensure that long flange on fifth gear faces forward.

NOTE (4 x 2 models): To install fifth gear assembly, perform the process in two steps. First, install Gear Installing Spacer T88T-7025-F. When tool bottoms, add Gear Installing Spacer T88T-7025-G, and press fifth gear assembly the rest of the way into position.

NOTE (4 x 4 models): Installation of fifth gear assembly is similar to 4 x 2 installation except that Remover/Replacer Tube T85T-7025-A and TOD Bearing Remover/Replacer Adapter T84T-7025-A are used.

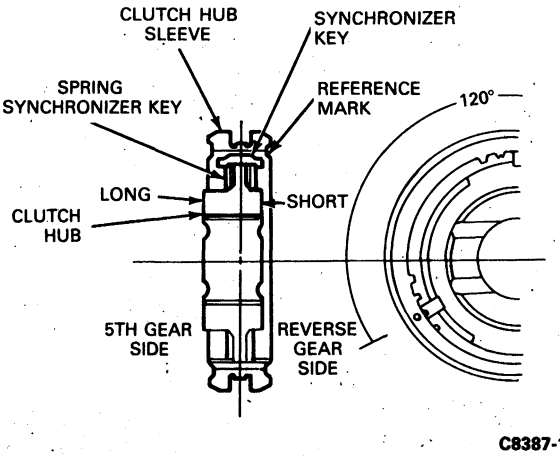


15. Position counter lever assembly to transmission and install thrust washer and retaining ring. Apply sealant to counter lever fixing bolt threads. Install counter lever fixing bolt and tighten to 8-10 N·m (6-7 ft-lb).
16. If removed, position fifth/reverse shift fork and shift rail to top cover. Insert fifth/reverse shift rail through top cover bore and fifth/reverse shift fork. Install spring and detent ball to lower part of rod.



17. Assemble the fifth/reverse synchronizer hub, sleeve, and fifth gear synchronizer ring to fifth/reverse shift fork and rod assembly.

NOTE: Install the longer flange (on the fifth/reverse hub, sleeve, and synchronizer assembly) toward the front of transmission. The reference mark on synchronizer sleeve must be installed toward reverse gear side.



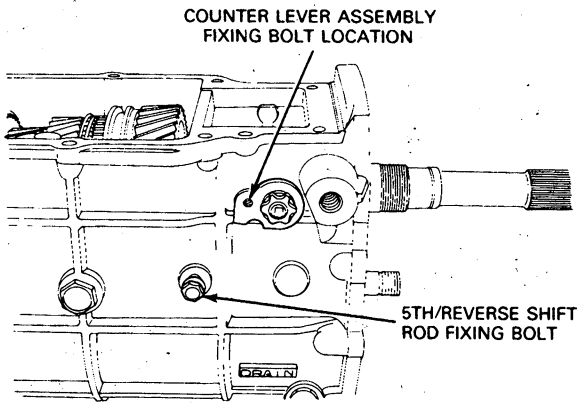
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CLEANING AND INSPECTION (Continued)

18. Install fifth/reverse shift fork and shift rail assembly (including fifth/reverse synchronizer hub, sleeve, and fifth gear synchronizer ring) to countershaft. Mate shift fork gate to fifth/reverse counter lever end. Install fifth/reverse fork and shift rail assembly with threaded fixing bolt bores (in rail and transmission case) aligned with each other.

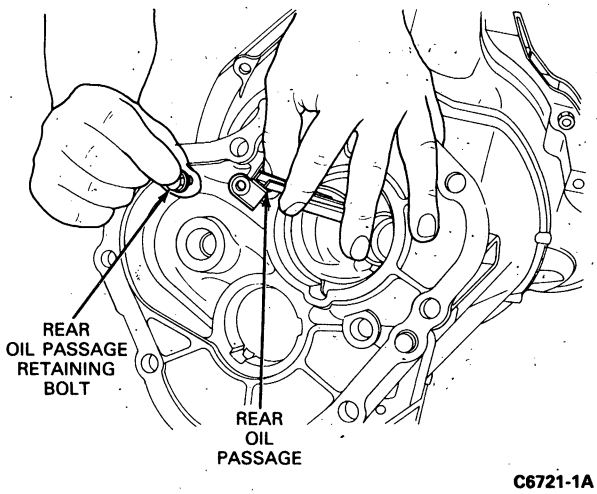
NOTE: For ease of assembly, position the fifth/reverse shift fork into the rearmost of the three detent positions (rearmost from threaded bore). Return shift fork to neutral gear position after installation.

a. Apply sealant to fifth/reverse shift rail fixing bolt threads. Install fifth/reverse shift rail fixing bolt to transmission case. Tighten fifth/reverse shift rail fixing bolt to 20-30 N·m (16-22 ft-lb).



C8418-1A

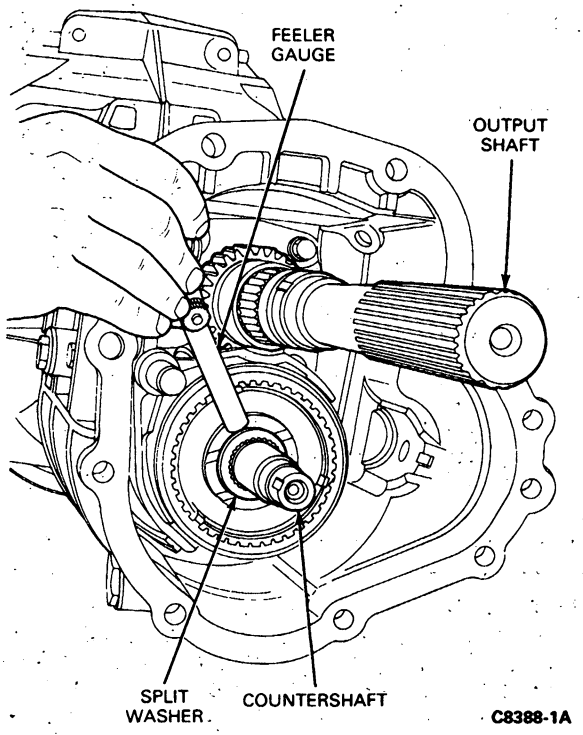
19. Apply sealant to oil passage retaining bolt. Position oil passage to transmission case and install retaining bolt. Tighten oil passage retaining bolt to 8-9 N·m (6-7 ft-lb).



C6721-1A

20. Install split washer and thrust washer onto countershaft.

NOTE: If clutch hub and/or counter reverse gear have been replaced, new split washers must be selected to maintain end play within specified limits. Measure end play using a feeler gauge. Select replacement split washers using the chart. Ensure that split washers are a matched set of identical thickness.



C8388-1A

SPLIT WASHER SELECT CHART

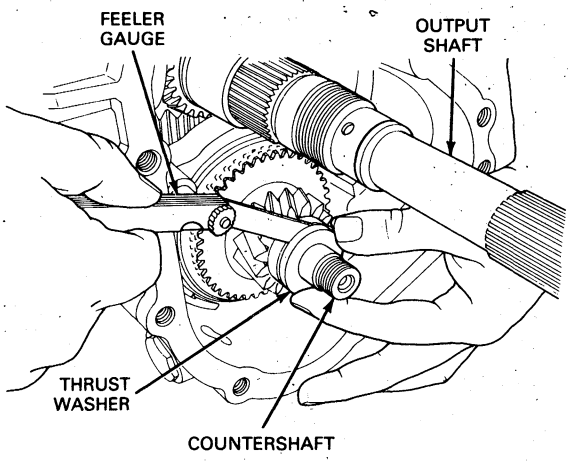
Part Number	Thickness
E8TZ-7R482-A	3.0mm (0.118 in.)
E8TZ-7R482-B	3.1mm (0.122 in.)
E8TZ-7R482-C	3.2mm (0.125 in.)
E8TZ-7R482-D	3.3mm (0.129 in.)
E8TZ-7R482-E	3.4mm (0.133 in.)
To Be Determined	3.05mm (0.120 in.)
To Be Determined	3.15mm (0.124 in.)
To Be Determined	3.25mm (0.127 in.)
To Be Determined	3.35mm (0.131 in.)
To Be Determined	3.45mm (0.135 in.)
To Be Determined	3.50mm (0.137 in.)

CC8389-1A

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CLEANING AND INSPECTION (Continued)

21. Install reverse synchronizer ring and needle bearings into counter reverse gear. Install counter reverse gear and needle bearings onto countershaft as an assembly. Install thrust washer to countershaft.
22. Press thrust washer forward (by hand) against shoulder on countershaft. Maintain forward pressure against thrust washer and insert feeler gauge between thrust washer and counter reverse gear. Using the chart, determine correct thrust washer to obtain specified end play. Counter reverse gear end play: 0.25-0.35mm (0.009-0.013 in.).



C8390-1A

THRUST WASHER SELECT CHART

Part Number	Thickness
E8TZ-7C340-A	7.45mm (0.293 in.)
E8TZ-7C340-B	7.65mm (0.301 in.)
E8TZ-7C340-C	7.85mm (0.309 in.)
E8TZ-7C340-D	7.35mm (0.289 in.)
E8TZ-7C340-E	7.55mm (0.297 in.)
E8TZ-7C340-F	7.75mm (0.305 in.)

CC8397-1B

23. Temporarily install a suitable spacer (inner bore larger than 21mm, outer bore smaller than 36mm, 15-20mm O/A length) in place of countershaft bearing. Loosely install countershaft locknut to retain components.

NOTE: Installation of a suitable spacer prevents thrust washer and split washers from slipping off shaft, and avoids interference with reverse idler gears.

24. Install reverse idler gear assembly. Apply sealant to reverse idler gear fixing bolt threads. Install and tighten fixing bolt to 79-116 N·m (58-86 ft-lb).
25. Drive sleeve and reverse gear assembly onto output shaft using Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover/Replacer Tube T75L-7025-B (4 x 2 models only), Remover/Replacer Tube T85T-7025-A (4 x 4 models only), nut, and washer, or equivalents.

NOTE: Install reverse gear with longer flange facing rearward.

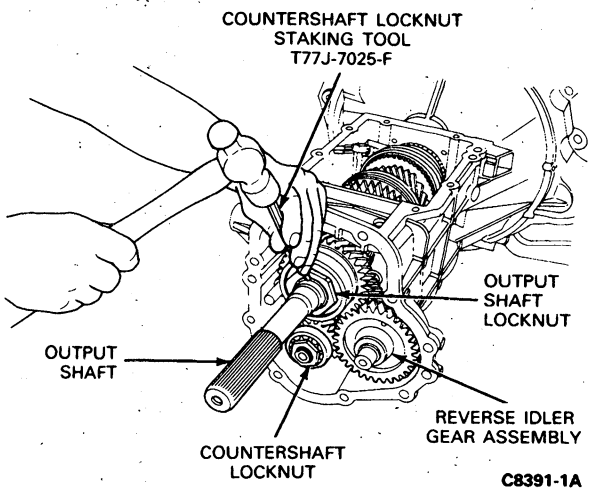
26. Install output shaft rear bearing using Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover/Replacer Tube T75L-7025-B (4 x 2 models only), or Remover/Replacer Tube T85T-7025-A (4 x 4 models only), nut, and washer, or equivalents.
27. Remove temporary spacer from countershaft.
28. Install countershaft rear bearing by hand.

NOTE: Tightening shaft locknuts without fully seating bearing can cause damage to output shaft threads.

29. Lock transmission into first and third gears. Install new output and countershaft locknuts hand tight. Tighten output shaft locknut to 216-274 N·m (160-200 ft-lb). Tighten countershaft locknut to 128-196 N·m (94-144 ft-lb).

NOTE: Always install new output and countershaft locknuts when assembling transmission. Locknuts unstaked during disassembly cannot be reused.

30. Stake (tightened) locknuts to bottom of shaft groove using Countershaft Locknut Staking Tool T77J-7025-F or equivalent.



C8391-1A

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CLEANING AND INSPECTION (Continued)

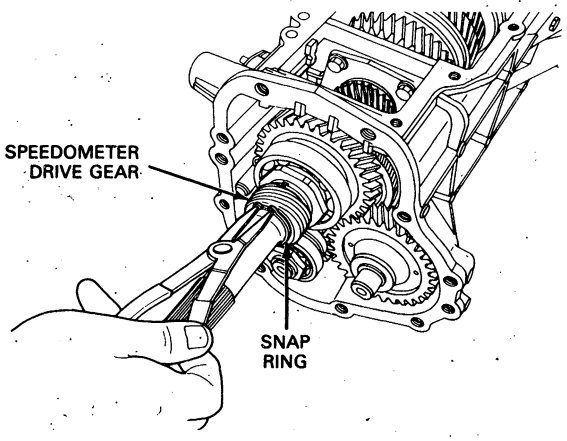
31. Install speedometer drive gear and steel ball to output shaft. Install snap ring retaining speedometer drive gear to output shaft (4 x 2 models only).

NOTE: The speedometer drive gear contains three detents into which the steel drive ball can be installed. The steel drive ball can be installed into any of the three detents.

NOTE: Depending upon application, one of two different speedometer drive gears may be installed. They are color coded (green, and white). When installing a speedometer drive gear, ensure that replacement gear is the same color as original. Speedometer drive gear part numbers and corresponding colors are as follows:

White (Natural)—E8TZ-17285-B

Green—E8TZ-17285-C



C6722-1A

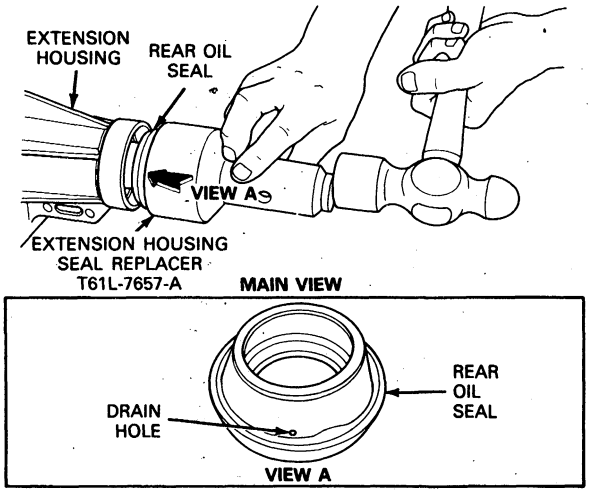
32. Remove any sealant residue from mating surfaces of transmission case and extension housing. Apply a 1/8-inch bead of Silicone Rubber D6AZ-19562-BA or equivalent to transmission case.

NOTE: Extension housing bushing cannot be serviced. If bushing requires service, extension housing must be replaced as a unit.

33. Position extension housing to transmission to case, and install extension housing retaining bolts. Tighten bolts to 32-46 N·m (24-34 ft-lb).
34. Place synchronizers into neutral gear position. Ensure that shift forks on top cover assembly are in neutral gear position.
35. Position top cover to transmission case, and carefully engage shift forks with synchronizers. Apply sealant to the two rearmost top cover retaining bolts, and install them into top cover rear retaining bolt locations. Install remaining top cover retaining bolts (no sealant). Tighten top cover retaining bolts to 16-22 N·m (12-16 ft-lb).

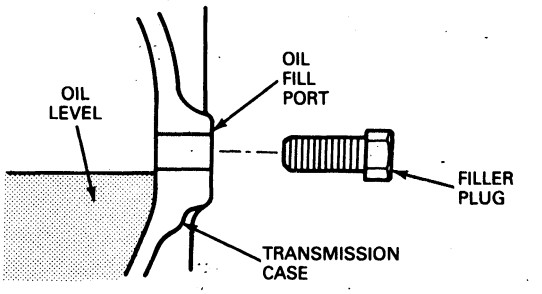
NOTE: Do not apply sealant to top cover or transmission case mating surfaces. If necessary, apply a small quantity of grease to sealing gasket to retain gasket in position during assembly.

36. Install transmission drain plug and tighten to 40-58 N·m (29-43 ft-lb).
37. If removed, install rear oil seal into extension housing using Extension Housing Seal Replacer T61L-7657-A or equivalent. Ensure that oil seal drain hole faces downward.



C8392-1A

38. Fill transmission with specified quantity of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX E4AZ-19582-B (ESP-M2C138-CJ) transmission fluid.



C8651-1A

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SPECIFICATIONS

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION — GEAR RATIOS

FIRST	3.90
SECOND	2.25
THIRD	1.50
FOURTH	1.00
FIFTH	.80
REVERSE	3.39

CC8403-1B

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION INSPECTION STANDARDS

Component	Tolerance	
	Inches	Millimeters
Mainshaft Runout Not to Exceed	0.002	0.05
Shift Fork to Clutch Sleeve Not to Exceed		0.8
Synchronizer Ring to Conical Face of Gear	0.059	1.5

CC8399-1A

TORQUE SPECIFICATIONS

Description	N•m	ft-lb
Output Shaft Locknut	216-274	160-203
Countershaft Locknut	128-196	94-144
Extension Housing Retaining Bolts	32-46	24-34
Reverse Idler Shaft Fixing Bolt	79-116	58-86
Center Bearing Cover	18-26	14-19
Front Bearing Cover	16-22	12-17
Fifth/Reverse Cam Lockout Plate	8-10	6-7
Dust Boot	8-11	6-8
Top Cover	16-22	12-16
Filler Plug	40-58	29-43
Front Oil Passage	8-10	6-8
Counter Lever Shaft Fixing Bolt	8-10	6-8
Rock Plate	8-10	6-7
Drain Plug	40-58	29-43
Backup Lamp Switch	25-35	18-26
Neutral Switch (If Equipped)	25-35	18-26
Rear Oil Passage (Extension Housing)	8-9	5-7
5th/Reverse Shift Rail Fixing Bolt	20-30	16-22

CC8402-1B

Transmission	U.S. Pints	Imperial Pints	Liters
Five-Speed Manual Overdrive Transmission MERCON® or Equivalent	7.6		3.55

CC8409-1B

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION ASSEMBLY STANDARDS

Component	Tolerance	
	Inches	Millimeters
3rd/4th Clutch Hub Play	0.00-0.0019	0.00-0.05mm
Reverse Idler Gear End Play	0.0039-0.0078	0.1-0.2mm
5th/Rev. Hub End Play	0.00-0.0019	0.00-0.05mm
Counter Reverse Gear	0.0098-0.0138	0.25-0.35

CC8400-1B

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SPECIAL SERVICE TOOLS

Number	Description	Number	Description
T74P-77248-A	Extension Housing Seal Remover	T71P-4621-B	Bearing Cone Remover
T77J-7025-F	Countershaft Locknut Staking Tool	D84L-1123-A	Bearing Splitter
T88T-7025-A	Mainshaft Locknut Wrench	T88T-7025-C	Top Cover Holding Fixture
T77J-7025-B	Remover/Replacer Tube	D84L-7000-B	Roll Pin Punch Set
T75L-7025-B	Remover/Replacer Tube	T88T-7025-F	Gear Installing Spacer
T84T-7025-B	TOD Forcing Screw	T88T-7025-G	Gear Installing Spacer
T77J-7025-H	Bearing Puller	T75L-7025-P	Shaft Adapter
T77J-7025-J	Puller Ring	T75L-7025-K	Shaft Adapter Screw
T75L-7025-G	Bearing Collet Sleeve For 3.5 Inch Bearing Collets	T61L-7657-A	Extension Housing Seal Replacer
T85T-7025-A	Remover/Replacer Tube	TOOL-4201-C	Dial Indicator
T84T-7025-A	TOD Bearing Remover/Replacer Adapter	T77J-7025-G	Front Cover Seal Installer
T88T-7061-A	Gear Removal Collet	T75L-7025-L	Shaft Adapter — Replacing
T88T-7120-A	Bearing Race Puller	T88T-7025-J2	Adapter
T50T-100-A	Slide Hammer	T88T-7025-J	Countershaft Fifth Gear Sleeve Puller
T53T-4621-B	Bearing Replacer	T88T-7025-J1	Gear Removal Collets
T88T-7025-B	Bearing Cone Replacer	D82L-4201-C	Depth Micrometer
T75L-1165-B	Bearing Plate		

CC8410-2B

ROTUNDA EQUIPMENT

Model	Description
077-00008	Transmission Jack

CC9439-1A

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SECTION 16-23 Borg-Warner T-18 Four-Speed Transmission

SUBJECT	PAGE
DESCRIPTION	16-23-1
DIAGNOSIS AND TESTING	16-23-1
DISASSEMBLY AND ASSEMBLY	
Sub-Assemblies	16-23-8
Countershaft Gear	16-23-9
Gear Shift Housing	16-23-10
Output Shaft	16-23-8
Reverse Idler Gear	16-23-10
Transmission	16-23-6
REMOVAL AND INSTALLATION	
Crossmember	16-23-4
F-150—F-250 (4X2)	16-23-1
F-150—F-250 and Bronco	16-23-4
Shift Lever	16-23-5
Transmission	16-23-1
SPECIFICATIONS	16-23-12
VEHICLE APPLICATION	16-23-1

VEHICLE APPLICATION

Applies to F-150—F-250 (4x2) (4x4) and Bronco.

DESCRIPTION

The four-speed Model T-18 transmission, (Fig. 1), is equipped with a center, floor-mounted gear shift lever.

The first and reverse gears are spur gears and the second, third and fourth speed gears are helical cut and are synchronized for ease in shifting.

The input shaft is supported by a ball bearing (Fig. 2), which is pressed onto the shaft and into the transmission case.

The front end of the output shaft is supported by a pilot bearing installed in the input shaft. The rear end of the output shaft is supported by a ball bearing which is pressed onto the shaft and into the transmission case. The bearing and shaft are retained in the case by a snap ring. The rear oil seal, speedometer gear, and rear bushing are contained in the extension housing, which is bolted to the rear of the case on F-150—F-250 (4x2) only.

DIAGNOSIS AND TESTING

Refer to Section 16-10, General Manual Transmission Service, for Diagnosis and Testing Procedures.

REMOVAL AND INSTALLATION

Transmission

F-150—F-250 (4X2)

Removal

1. Remove the floor mat, the body floor pan cover, the gearshift lever shift ball and boot as an assembly. Remove the isolator pad.
2. Raise the vehicle and position safety stands. Position a transmission jack such as Rotunda 022-00003, or equivalent under the transmission, and disconnect the speedometer cable.
3. Disconnect the back-up lamp switch located at the rear of the gear shift housing cover (Fig. 1).
4. Disconnect the driveshaft or coupling shaft and clutch linkage from the transmission and wire it to one side.
5. Remove the transmission attaching bolts.
6. Move the transmission to the rear until the input shaft clears the clutch housing. Lower the transmission.

Installation

1. Place the transmission on a transmission jack, install guide studs in the clutch housing and raise the transmission until the input shaft splines are aligned with the clutch disc splines. The clutch release bearing and hub must be properly positioned in the release lever fork.
2. Slide the transmission forward on the guide studs until it is in position on the clutch housing. Install the attaching bolts and tighten them to 48-67 N·m (35-50 ft-lb). Remove the guide studs and install the two lower attaching bolts.
3. Connect the speedometer cable and driven gear and clutch linkage.
4. Install the bolts attaching the front U-joint of the coupling shaft to the transmission output shaft flange. Tighten the bolts and nuts to specifications as listed in the specifications of Section 15-60, Driveshaft—Single Type U-Joint.
5. Connect the back-up lamp switch.
6. Install the shift lever, boot and shift ball as an assembly and lubricate the spherical ball seat with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
7. Install the isolator pad. Install the floor pan cover and floor mat.

Transmission

F-150—F-250 (4X4) BRONCO

Removal

1. Open door and cover seat.
2. Remove the four screws holding the floor mat.

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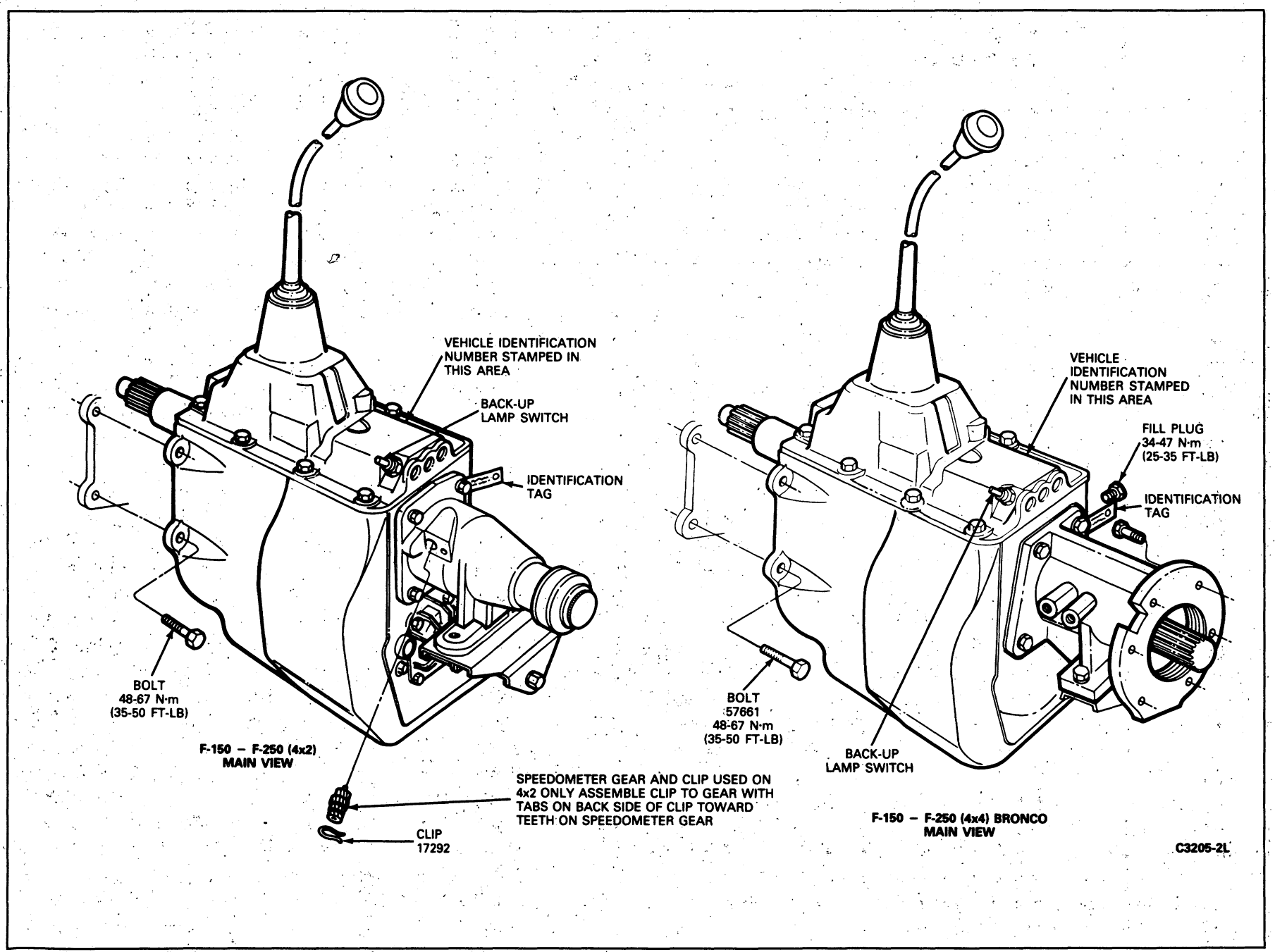


FIG. 1 Borg-Warner T-18 Four-Speed Transmission

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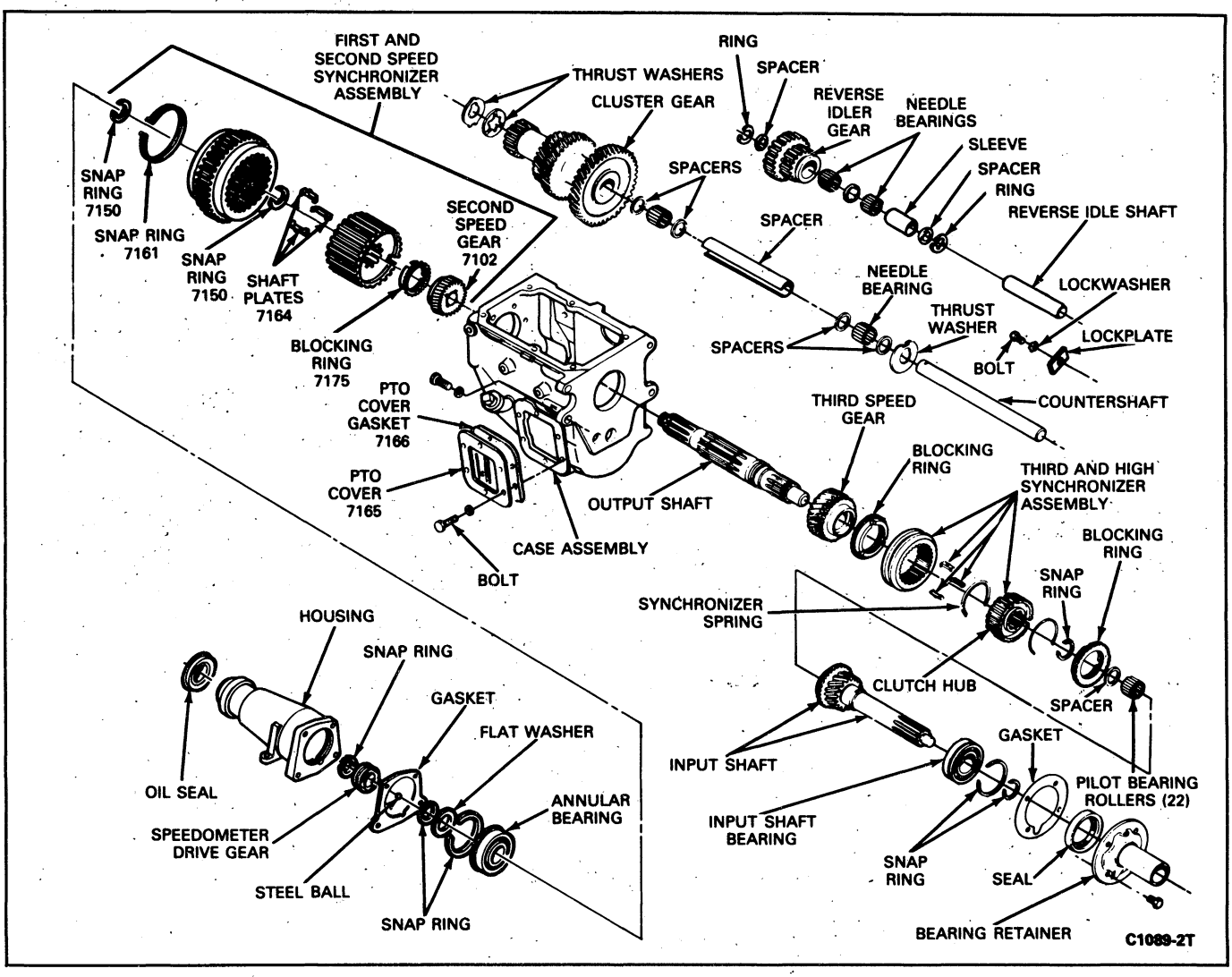


FIG. 2 Typical Warner Four-Speed Transmission

3. Remove the eleven screws holding the access cover to the floor pan. Place the shift lever in the reverse position and remove the cover.
4. Remove the insulator and dust cover.
5. Remove the transfer case shift lever, shift ball and boot as an assembly.
6. Remove transmission shift lever, shift ball and boot as an assembly.
7. Raise the vehicle on a hoist.
8. Remove the drain plug and drain the transmission.
9. Disconnect the rear driveshaft from the transfer case and wire it out of the way.
10. Disconnect the front driveshaft from the transfer case and wire it out of the way.
11. Remove the shift link from transfer case.
12. Remove the speedometer cable from the transfer case.
13. Position a transmission jack under the transfer case. Remove the six bolts holding the transfer case to the transmission and lower the transfer case from the vehicle.
14. Remove the eight bolts that hold the rear support bracket to the transmission.
15. Position a transmission jack under the transmission and remove the rear support bracket and brace.
16. Remove the four bolts that hold the transmission to the bell housing.
17. Remove the transmission from the vehicle.

Installation

1. Place the transmission on a transmission jack and install it in the vehicle installing two guide studs in the bell housing top holes, to guide the transmission into position.
2. Install the two lower bolts. Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the eight retaining bolts.
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack and install the six retaining bolts and gasket. Position the transfer case on the transmission and

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tighten the bolts as listed in the appropriate transfer case section.

6. Install the transfer case shift link.
7. Position and install the speedometer cable.
8. Remove wire and connect front driveshaft.
9. Remove wire and connect rear driveshaft.
10. Fill transfer case with MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent and fill the manual transmission with Standard Transmission Lubricant (SAE 80W), D8DZ-19C547-A (ESP-M2C83-C) lubricant or equivalent.
11. Lower vehicle.
12. Remove fabricated dirt shield and prepare gasket area.
13. Position gasket and shift cover.
14. Install two pilot bolts, then install remaining shift cover retaining bolts.
15. Install transfer case shift lever, shift ball and boot as an assembly and transmission shift lever, shift ball and boot as an assembly.
16. Install dust cover and insulator.
17. Install access cover to floor pan screws.
18. Install the four floor mat screws.
19. Install the four boot area screws.

Crossmember

F-150—F-250 and Bronco

Refer to Figs. 3 and 4.

Removal

1. Raise vehicle on hoist.
2. Remove skid plate, if so equipped. Remove heat shield from catalytic converter.

   CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extremely high temperatures generated by the converter.
3. Remove two nuts connecting upper gusset to frame on both sides of the frame.
4. Remove nut and bolt assembly connecting gusset to crossmember. Remove gusset on left side.
5. Remove bolts holding transmission to transmission support plate on crossmember (4x4).
6. Remove bolts attaching transmission to insulator (4x2).
7. Raise transmission with a transmission jack.
8. Remove the nut and bolt assemblies connecting the support plate to crossmember. Remove support plate. Remove right gusset (4x4).
9. Remove nuts attaching insulator to crossmember. Remove insulator. Remove right gusset (4x2).
10. Remove nut and bolt assemblies connecting crossmember to frame. Remove crossmember.

Installation

1. Install crossmember and transmission support plate, and position right and left gussets on bolts in frame (4x4).
2. Install crossmember and insulator and position right and left gussets on bolts to frame (4x2).

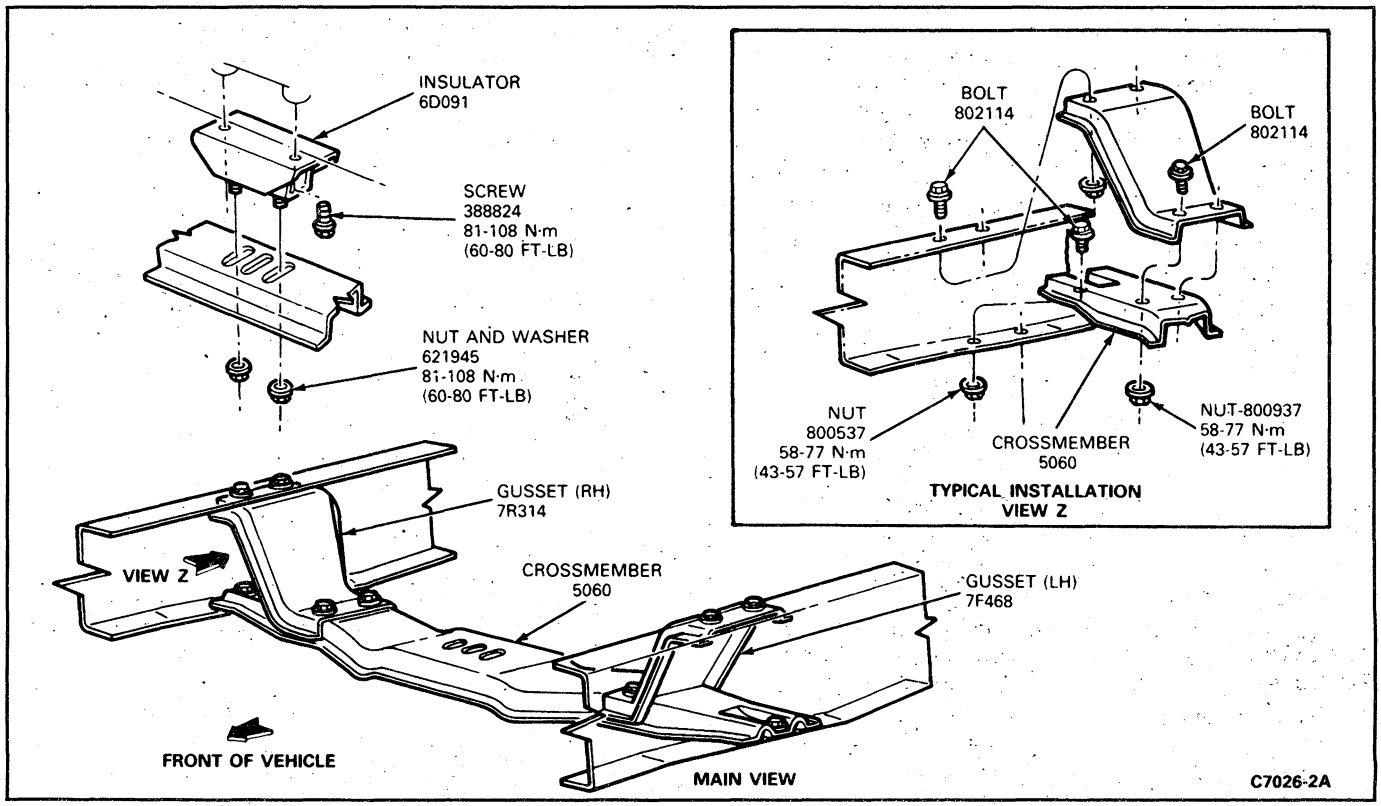


FIG. 3 Crossmember Installation—F-150—F-250 (4x2)

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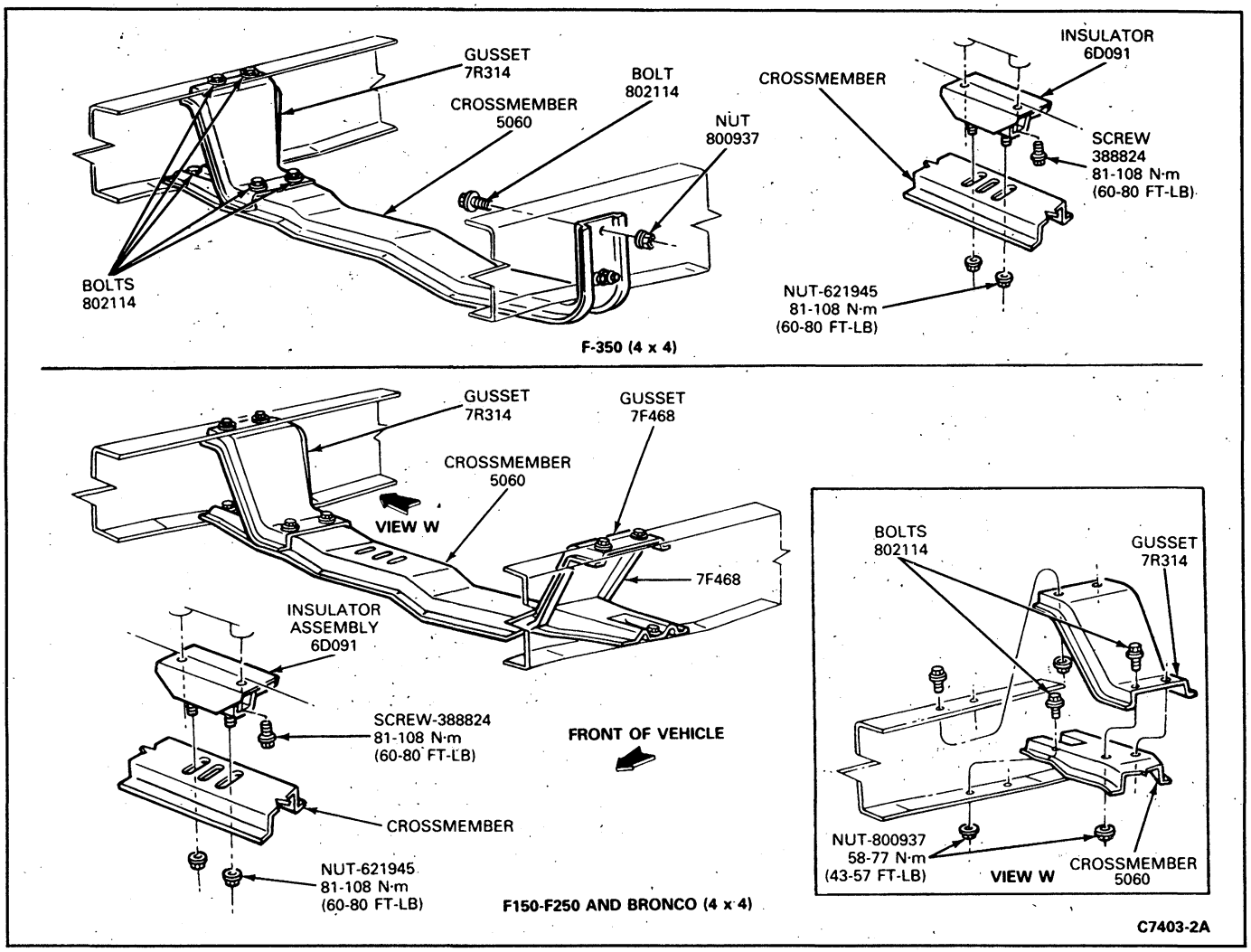


FIG. 4 Crossmember Installation—F-150—F-250 (4x4) and Bronco

3. Install nuts on upper gusset to frame bolts and tighten to specification.
4. Install crossmember to frame nut and bolt assembly and tighten to specification.
5. Install nut and bolt assembly connecting gusset to crossmember and tighten to specification.
6. Install nut and bolt assemblies connecting transmission support plate to crossmember and tighten to specification (4x4).
7. Install nuts connecting insulator to crossmember and tighten to specifications (4x2).
8. Lower the transmission.
9. Install bolts connecting transmission support plate to transmission and tighten to specification.
10. Install bolts connecting insulator to transmission and tighten to specifications (4x2).
11. Install skid plate, if so equipped. Install heat shield over catalytic converter. Tighten all nuts and bolts to specification.
12. Lower vehicle.

Shift Lever

NOTE: Remove the shift ball only if the shift ball, boot or lever is to be replaced. If either the ball, boot or lever is not being replaced, remove the ball, boot and lever as an assembly.

Removal

1. Remove the plastic insert from the shift ball. Warm the ball with a heat gun to 60°-82°C (140°-±80°F) knock the ball off the lever with a block of wood and a hammer, taking care not to damage the finish on the shift lever.
2. Remove the rubber boot and floor pan cover.
3. Shift the unit into second gear, remove the lock pin and remove the shift lever from the shifter housing.

Installation

1. Install the shift lever in the shifter housing, making sure that the slot in the lever aligns with the tab in the housing. Install the lock pin.
2. Install the rubber boot and floor pan cover.
3. Warm the ball with a heat gun to 60°-82°C (140°-180°F) and tap the ball on the lever with a 7/16 inch socket and mallet. Install the plastic shift pattern insert.

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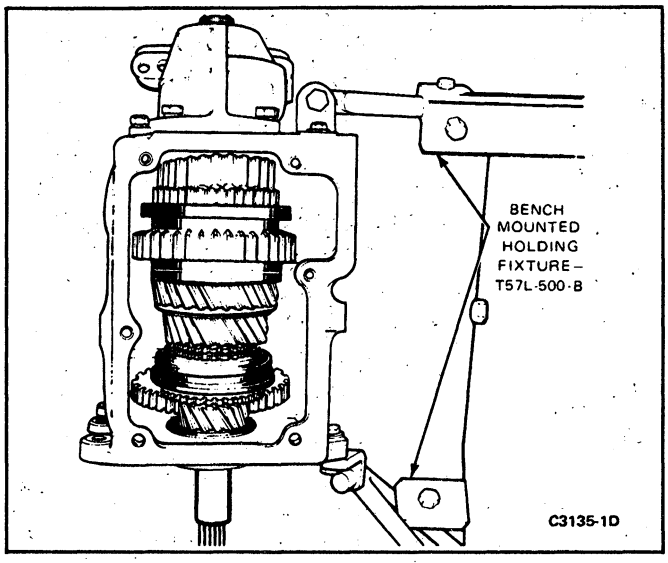


FIG. 5 Transmission in Holding Fixture

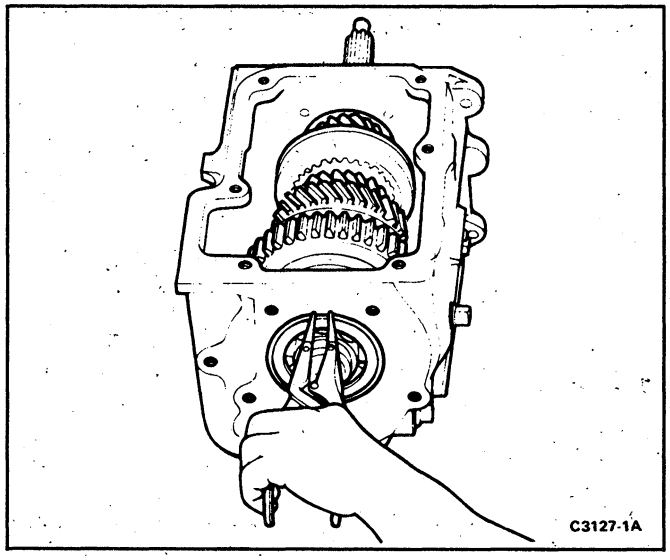


FIG. 6 Removing Output Shaft Bearing Snap Ring

DISASSEMBLY AND ASSEMBLY

Transmission

Refer to Fig. 2.

Disassembly

1. Position the transmission assembly in a suitable holding fixture T57L-500-B or equivalent (Fig. 5). Drain the transmission and shift the unit into second gear before removing the housing assembly.
2. Lock the transmission in two gears; then, remove the U-joint flange and oil seal.
3. Remove the speedometer driven gear and bearing assembly.
4. Remove the output shaft bearing retainer (or extension housing).
5. Remove the speedometer drive gear snap ring retainer. Slide the speedometer drive gear off the output shaft.

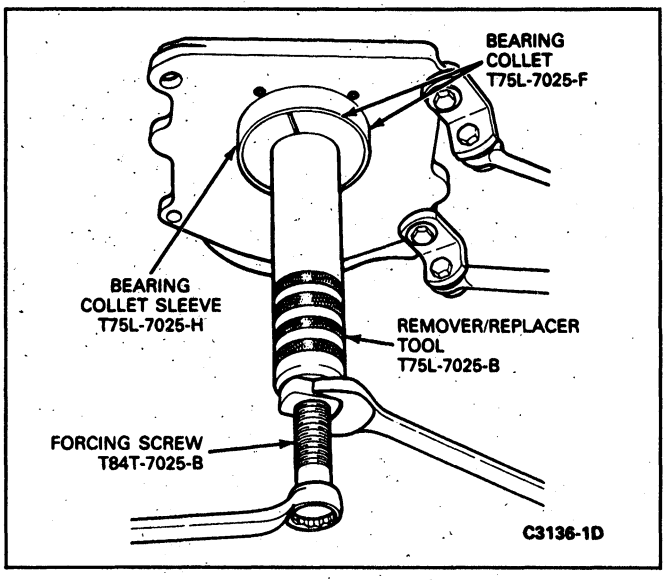


FIG. 7 Removing Output Shaft Bearing

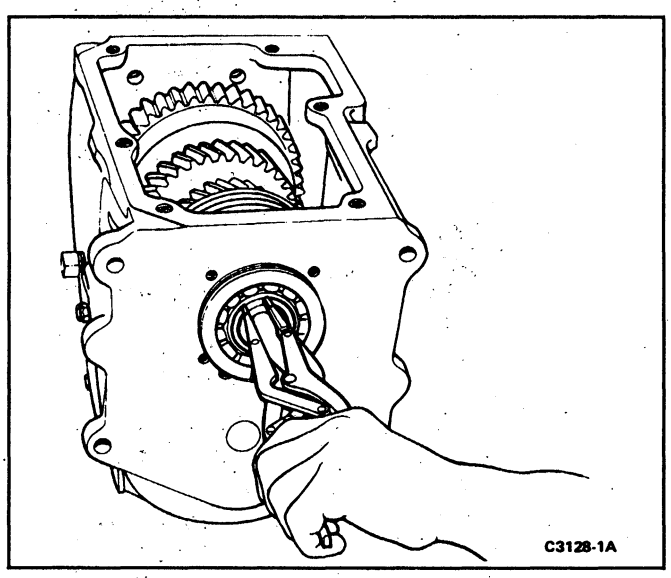


FIG. 8 Removing Input Shaft Bearing Snap Ring

6. Remove the output shaft bearing snap ring retainers from the output shaft and from the bearing, (Fig. 6). Remove bearing spacer.
7. Install Tool, T75L-7025-B, F, H and T84T-7025-B on the output shaft and over the output shaft bearing (Fig. 7). Remove the output shaft bearing.
8. Remove the input shaft bearing retainer. Remove the input shaft bearing snap ring from the input shaft and from the bearing, (Fig. 8).
9. Install tool on the input shaft and over the input shaft bearing. Remove the input shaft bearing.
10. Remove the output shaft assembly from the case (Fig. 9).
11. Remove the input shaft assembly from the case (Fig. 10). Do not lose the 22 pilot bearing rollers from the inner end of the shaft.
12. Remove the reverse idler gear shaft and the countershaft retainer from the end of the transmission case (Fig. 11).

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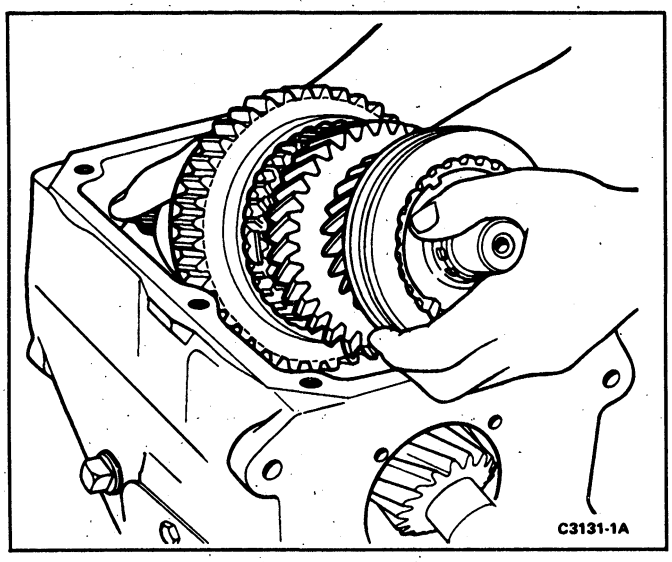


FIG. 9 Removing Output Shaft Assembly

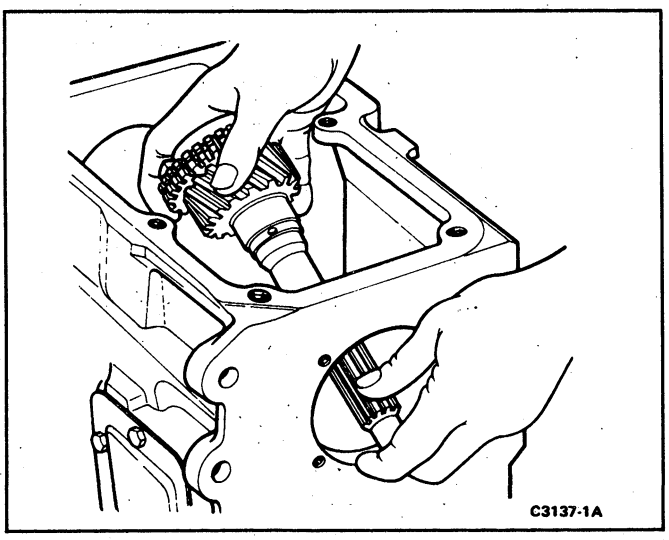


FIG. 10 Removing Input Shaft Assembly

13. Remove the reverse idler gear shaft, using the Tools, T50T-100-A and T50T-7140-C, or their equivalents, as shown in Fig. 12.
14. Remove the reverse idler gear from the case.
15. Remove the countershaft with the same tools used to remove the reverse idler gear shaft.
16. Install a suitable dummy shaft tool in the countershaft. Remove the countershaft gear assembly from the case. Guide the countershaft assembly (with the dummy shaft tool installed) out of the case so that the roller bearings and spacers that remain in the countershaft are not lost.

Assembly

NOTE: If a bearing is not used, be sure that a protector is used over the 3-4 synchronizer to prevent jamming the 4th blocking ring onto the cone seat.

1. Coat all parts, especially the bearings, with specified transmission lubricant to prevent scoring when the transmission is first put into operation.
2. Position the countershaft gear assembly thrust washers in the transmission case.

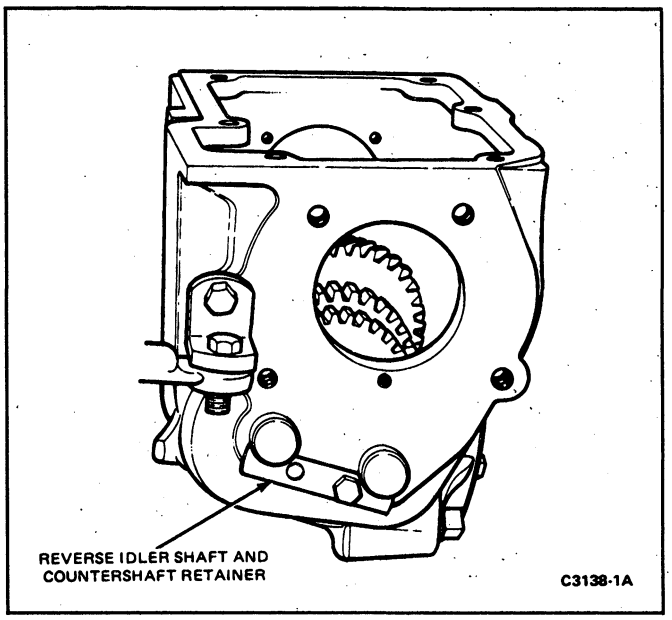


FIG. 11 Reverse Idler Gear Shaft and Countershaft Retainer

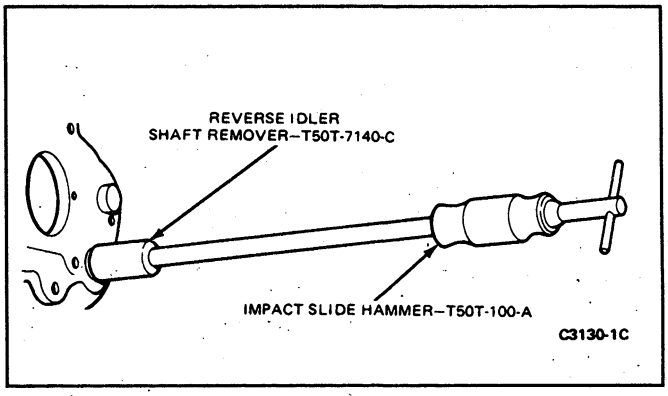


FIG. 12 Removing Reverse Idler Gear Shaft

3. Position the countershaft gear assembly (with dummy shaft tool installed) in the transmission case. **Use care so that no roller bearings are lost, and so that the thrust washers are not moved out of position.**
4. Carefully, drive out the countershaft gear assembly dummy shaft by installing the countershaft from the rear of the transmission case. **Position the slot in the rear of the countershaft so that it can be engaged by the shaft retainer.**
5. Position the reverse idler gear assembly in the transmission case, and install the reverse idler gear shaft. **Position the slot in the rear of the shaft so that it can be engaged by the shaft retainer.**
6. Install the countershaft and reverse idler gear shaft retainer.
7. Load the 22 pilot bearing rollers in the inner end of the input shaft (use petroleum jelly to keep the pilot bearings in position). Position the input shaft assembly in the transmission case and install the blocking ring on the input shaft.
8. Install the output shaft assembly in the transmission case. **Use care so that the pilot**

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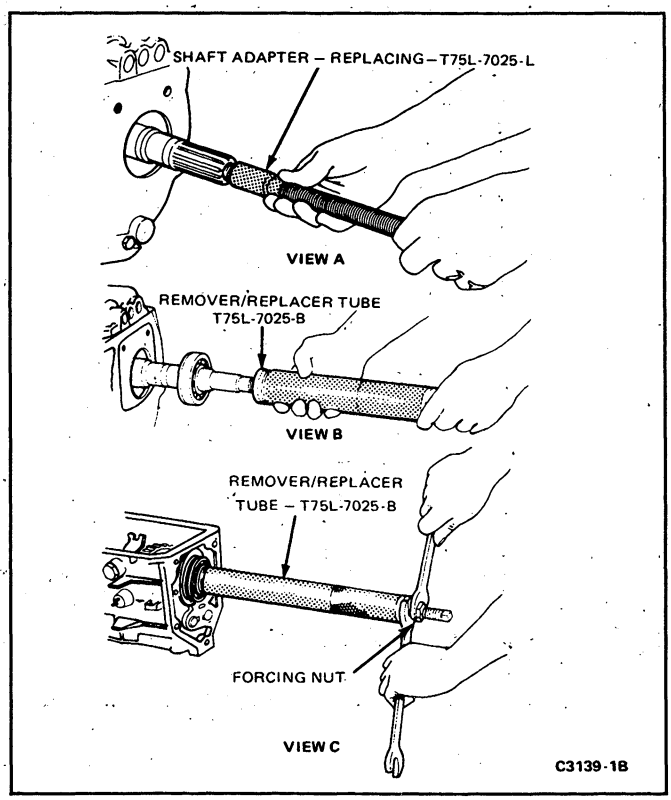


FIG. 13 Installing Output Shaft Bearing

bearing rollers are not permitted to drop out of the input shaft.

9. Install a dummy bearing (Tool T75L-7025-Q or equivalent) on the transmission input shaft. This tool is necessary to keep the input and output shafts in alignment when installing the output shaft bearing.
10. Assemble the locating snap ring to the outer race of the output shaft bearing in the groove provided.
11. Install the output shaft bearing using the tools, T75L-7025-B, L (or equivalent) as shown in Fig. 13.
12. Install the flatwasher against the rearward face of the output shaft bearing. (The properly installed washer will be external to the main body of the transmission.)
13. Install a snap ring at the rearward surface of the washer in the output shaft groove provided.
14. Remove the dummy bearing from the input shaft.
15. Install the input shaft bearing using the Tools, T75L-7025-B, K, R, S (or equivalents) as shown in Fig. 14 and install the snap ring. Use the thickest select fit snap rings which will fit on the bearing.
16. Install the input shaft bearing spacer and retainer gasket and retainer. Tighten the bolts to specification.
17. Position the speedometer drive gear (and spacer, if used) on the output shaft over lock ball and install the speedometer drive gear retaining snap ring.
18. Using a new gasket install the output shaft bearing retainer (or extension housing). Tighten the bolts to specification.

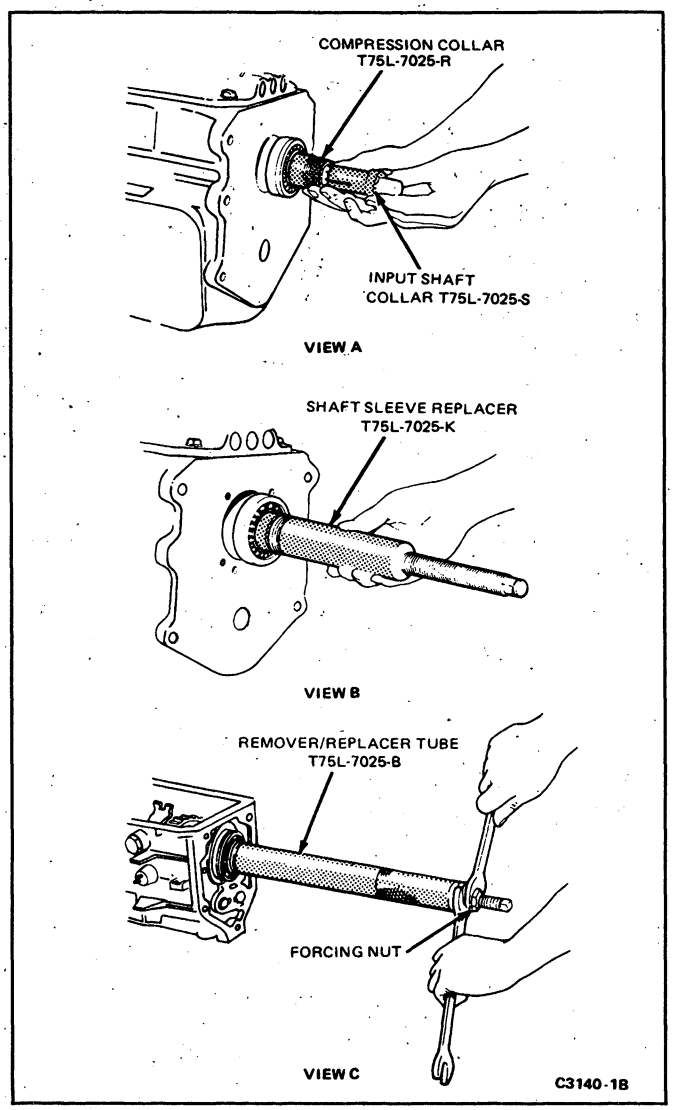


FIG. 14 Installing Input Shaft Bearing

19. Lubricate the extension housing bushing and seal and the U-joint flange with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent.
20. Install the U-joint flange. Lock the transmission in two gears and tighten the retaining nut to specifications.
21. Install the gear shift housing assembly (with Standard Transmission Lubricant (SAE 80W), and unit shifted into second gear) on the transmission and tighten the cover bolts to specification.
22. Fill the transmission to the proper level with Standard Transmission Lubricant (SAE 80W) D8DZ-19C547-A (ESP-MC83C) or equivalent. Add 1/4 liter (1/2 pint) of lubricant through the speedometer cable hole in the rear transmission extension housing.

Sub-Assemblies

Output Shaft

Refer to Fig. 2.

Disassembly

1. Remove the third- and high-speed synchronizer hub snap ring from the output shaft, and slide the

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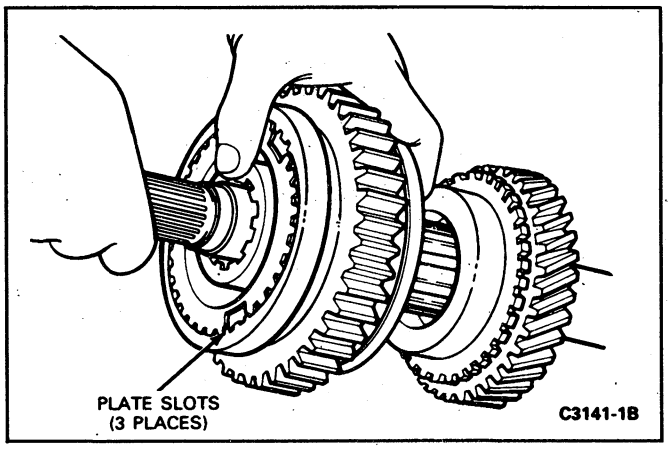


FIG. 15 Removing Second Gear Synchronizer—Assembly

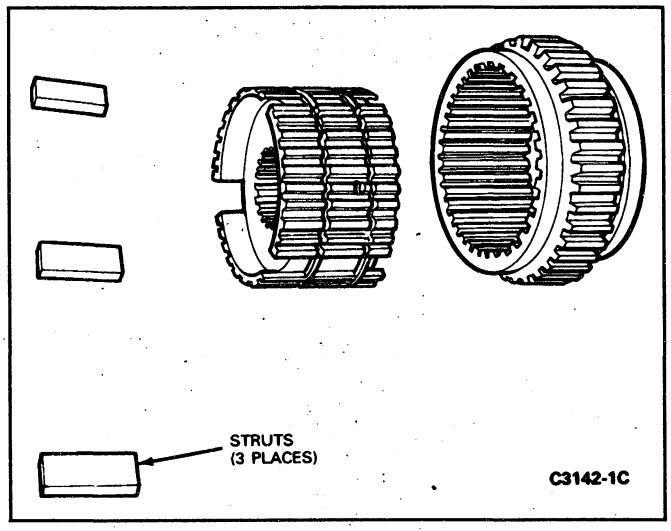


FIG. 16 Second Speed Synchronizer—Disassembled

third- and high-speed synchronizer assembly and the third-speed gear off the shaft.

2. Remove the synchronizer sleeve and the inserts from the hub.
3. Before removing the two snap rings from the ends of the hub, check the end play of the second speed gear. There should be 0.127-0.609mm (0.005 to 0.024 inch) of end play.
4. Make an index mark on gear and hub before disassembly to insure same hub and gear alignment upon reassembly. These parts are matched parts. Slide the low and second speed gear off the hub. Be careful not to lose springs, or plates (Figs. 15 and 16).
5. Remove the snap ring from behind the synchronizer hub. Pull synchronizer hub from the shaft. Remove the blocking ring.
6. Remove the snap ring from behind the second speed gear and remove the gear and thrust washer from the output shaft.

Assembly

1. Place output shaft with threaded end up in a soft-jawed vise.

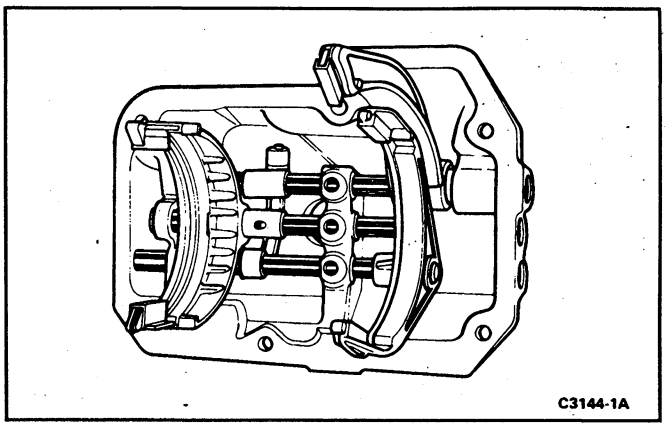


FIG. 17 Shift Housing Removed—Second Gear Position

2. Place second speed gear against thrust washer flange on shaft, then assemble snap ring in groove behind gear.
3. Place blocking ring on second speed gear.
4. Assemble the second speed synchronizer assembly over the splines of main shaft, aligning the three blocking ring cut-outs with shifting plates. The low and second gear shift fork groove should be located to rear of transmission.
5. Place a snap ring in the main shaft groove behind clutch hub.
6. Turn output shaft over and assemble third speed gear against output shaft shoulder.
7. Place blocking ring on third speed gear.
8. Assemble third and high synchronizer assembly over output shaft splines. Align the three blocking ring slots with shifting plates and position the end of the hub which has the long chamfer to the front of the transmission.
9. Place snap ring in output shaft groove in front of third and high synchronizer assembly.
10. Assemble spacer on output shaft.

Countershaft Gear

Refer to Fig. 2.

Disassembly

Remove the dummy shaft, bearing rollers, bearing spacers, and the center spacer from the countershaft gear.

Assembly

1. Slide the long bearing spacer (Fig. 2) into the countershaft gear bore, and insert the dummy shaft in the spacer.
2. Apply a film of petroleum jelly to the countershaft gear bore and install one of the bearing spacers. Position the 22 bearing rollers in the gear bore.
3. Place a spacer in the gear bore.
4. Hold a large thrust washer against the end of the countershaft gear to prevent the rollers from dropping out, and turn the assembly over. Install bearing spacer, 22 rollers and a spacer.

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Reverse Idler Gear

Disassembly

Replace the reverse idler gear if the gear or roller bearing is badly worn or if the teeth are chipped or burred. Replace the reverse idler gear shaft if it is excessively worn or scored.

Gear Shift Housing

Refer to Fig. 17.

Disassembly

1. Remove the floor mat or carpet, rubber boot cover and floor pan cover. Remove front seat assembly if necessary.
2. Remove the foam weather pad from the gear shift housing.
3. Shift the unit into second gear and remove the gear shift lever from the transmission. Then, disconnect the back-up lamp switch from the connector and remove the back-up lamp switch from the rear of the gear shift housing.
4. Remove the shift housing tower from the transmission (Fig. 18).

   NOTE: After the shift housing tower is removed, inspect all internal transmission components for damage, chips and/or foreign material within the transmission case assembly.
5. Remove the three expansion plugs from the forward end of the shift housing (Fig. 18). Using a pin punch, remove the three lock pins from the shift forks and the three lock (roll) pins from the gear shifter shaft gates.
6. Tap the shifter shaft(s) out of the housing (forward) while holding a shop towel over the poppet ball(s), (Fig. 19), and spring hole(s) in the housing to prevent loss of spring(s) and/or poppet ball(s).
7. Remove the interlock pin from the middle shift rail (Fig. 19).
8. Remove the shift forks and shift gates.

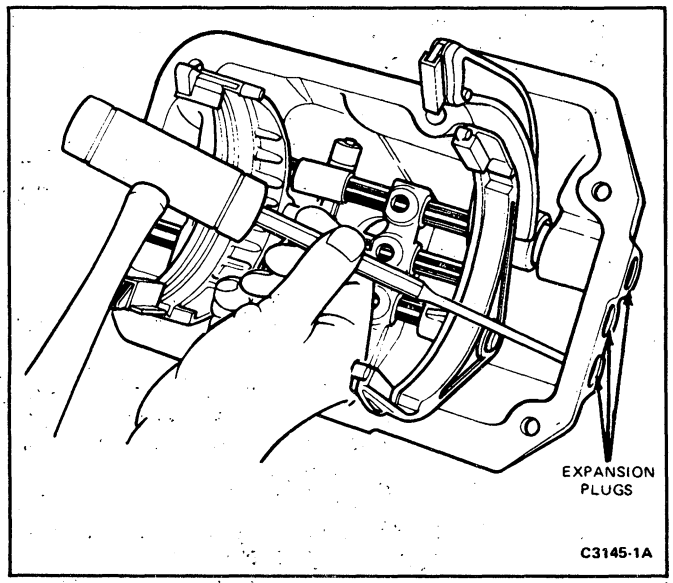


FIG. 18 Removing Expansion Plugs from Shift Housing

9. Remove the poppet balls and springs from the housing. Then, remove the interlock plungers from the housing.

Assembly

1. Install the spring and plunger in the reverse gate, press the plunger through the gate and fasten it in place with the clip, if the reverse gate assembly has been disassembled.
2. Place the poppet spring and ball in the reverse shifter shaft hole in the gear shift housing. Insert the shaft part way into the housing. Install the reverse shift fork on the shaft (reverse shifter) then, press down on the poppet ball and spring with a long thin drift and position the reverse shifter ball notch so that it does not slide over the ball.
3. Slide the reverse gate onto the shaft (long end forward), and drive the shaft into the housing until the ball snaps into the groove of the shaft. Install the lock pin that fastens the gate to the shaft.
4. Insert the two interlocking plungers in the pockets between the shifter shaft holes. Place the poppet spring and ball in the low-and-second shifter shaft hole. Press down on the poppet ball and spring with a long thin drift and insert the shifter shaft part way into the housing.
5. Slide the low-and-second shifter shaft gate onto the shaft, and install the low-and-second shifter fork on the shaft so that the off-set of the fork is toward the rear of the housing. Push the shaft all the way into the housing until the poppet ball snaps into the shaft groove. Then, install the lock pins that fastens the fork and gate to the shaft.
6. Insert the three-four shifter shaft through the center rear hole of the housing. Then, insert the interlock pin into the interlock pin hole in the shifter shaft.

   NOTE: Apply a daub of petroleum jelly to hold the pin in position.
7. Apply a coating of petroleum jelly to the interlock plungers and insert them into their respective holes in the housing.
8. Place the poppet spring and ball in the center shifter shaft hole in the housing. Press down on the poppet ball with a long thin drift, and carefully push the shifter shaft into the housing over poppet ball and spring.
9. Position the third-fourth shift gate onto the shifter shaft. The spring loaded-ball tang should be installed facing rear of transmission.

   NOTE: It is extremely important that the shift gate be installed on the shifter shaft with the long flat "tang" end of the gate area facing forward of the gear shift housing. To insure proper installation, measure the two flat "tangs" of the shift gate, note the longer dimension 18.25mm (23/32 inch) and apply a daub of bright paint. This tang should be installed facing forward on the shifter shaft.
10. Position the three-four shifter fork on the shifter shaft so that the lockpin hole in the shifter fork is toward the rear of the housing. Push the shifter shaft into the housing until the poppet ball seats into the second detent (neutral). Install the lock pins attaching the shifter fork and shifter gate to the shifter rail.

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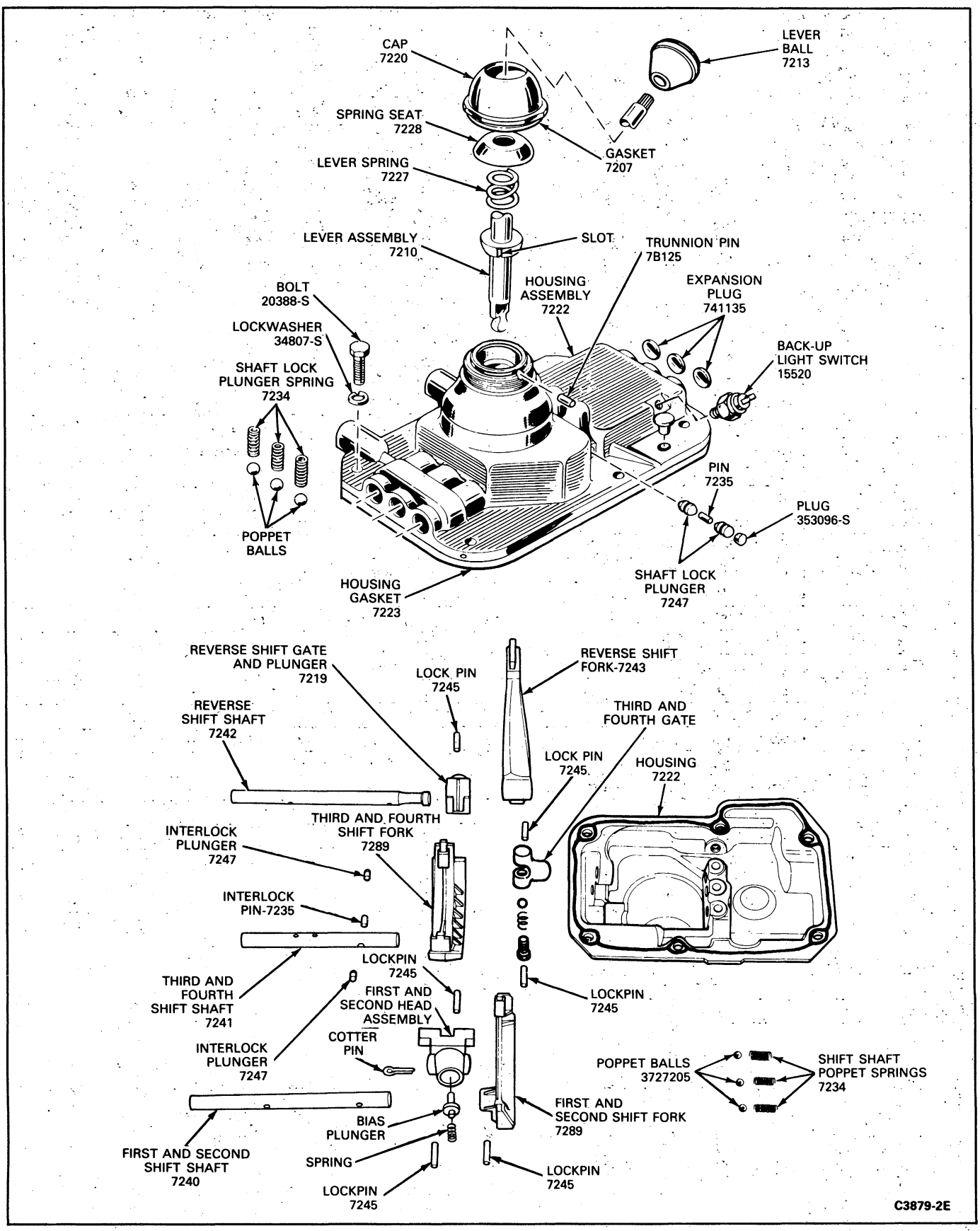


FIG. 19 Shift Housing—Disassembled

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NOTE: Install the shifter gate lock pin so that the pin is flush with the bottom of the notch in the shifter gate.

11. Install new expansion plugs in front and rear of transmission housing.
12. Shift the gear shift housing into the "second gear" position. Shift the transmission gears into the "second gear" position. Install the back-up lamp switch and connect the wiring. Then, place the transmission gear shift housing onto the transmission.
13. Apply Pipe Sealant with Teflon D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent to the six shift gear housing-to-transmission case attaching bolts. Tighten the bolts to 24-27 N·m (17-20 ft-lb).
14. Position the foam weather pad on the gear shift housing. Install the gear shift lever. Install cab floor pan cover, rubber boot and floor mat or carpet. Install front seat.
15. Fill transmission with Standard Transmission Lubricant (SAE 80W), D8AZ-19C547-A (ESP-M2C83-C) or equivalent, ADD 1/4 liter (1/2 pint) of lubricant through the speedometer cable hole in the rear transmission retainer.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T57L-500-B	Bench Mounted Holding Fixture	Universal
T00L-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T75L-4201-A	Clutch Housing Alignment Adapter	Use for Right Angle Measurements
T75L-4201-B	Clutch Housing Alignment Adapter	Universal
D78P-4201-B	Dial Indicator with Base	Universal
T00L-4201-C	Dial Indicator with Bracketry	Universal
T75L-6392-A	Clutch Housing Alignment Tool	Universal
D79L-7000-A	Retaining Ring Pliers	Universal
T72J-7025	Mainshaft Bearing Cone Replacer	0.921 Inch Inside Diameter
T71P-7025-A	Output Shaft Bearing Replacer	1.063 Inch Inside Diameter
T75L-7025-B	Remover/Replacer Tube	Warner T-18 Transmission — Output Shaft Bearings
T75L-7025-F	Bearing Collet	Warner T-18 Transmission
T75L-7025-H	Bearing Collet Sleeve	Warner T-18 Transmission
T84T-7025-B	Forcing Screw	Universal — Use with Remover/Replacer Tube
T75L-7025-K	Shaft Sleeve Replacer	Use with Compression Collar and Input Shaft Collet
T75L-7025-L	Shaft Adapter — Replacing	Use with Remover/Replacer Tube
T77L-7025-L	Manual Transmission Bearing Set	Universal
T75L-7025-Q	Dummy Bearing	Warner T-18 Transmission
T75L-7025-R	Compression Collar	Warner T-18 — Use with Shaft Sleeve Replacer and Input Shaft
T75L-7025-S	Impact Shaft Collet	Warner T-18 — Use with Shaft Sleeve Replacer and Compression Collar
T50T-7140-C	Reverse Idler Shaft Remover	Use with Slide Hammer

CC4862-2C

ROTUNDA EQUIPMENT

Number	Description
066-00017	Transmission Jack

CC7402-1B

APPROXIMATE REFILL CAPACITY — WARNER T-18

Lubricant	Approximate Capacity		
	U.S. (Pints)	Imperial (Pints)	Liters
Standard Transmission Lubricant (SAE 80W) (D8DZ-19C547-A [ESP-M2C83-C] or equivalent)	7.0	5.5	3.3

CC3593-2E

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TORQUE SPECIFICATIONS — WARNER T18 — TRANSMISSION

Description	Size	Torque Limits	
		(ft-lbs)	N-m
Back-Up Light Switch	9/16-18	15-25	20-47
Clutch Housing to Transmission Mounting Bolts	7/16-14	35-50	47-67
Case Cover	3/8-16	25-35	34-47
Countershaft Rear Retainer	3/8-16	25-35	34-47
Drain Plug	3/4-14	25-40	34-54
Filler Plug	3/4-14	25-40	34-54
Output Shaft Flange Nut	3/4-20	75-110	102-149
Mainshaft Rear Retainer	3/8-16	25-35	34-47
	1/2-13	40-50	54-67
P.T.O. Cover Bolt	3/8-16	25-35	34-47
Reverse Idler Shaft/Countershaft Locking Bolt	3/8-16	25-35	34-47
Front Bearing Retainer to Case	5/16-18	10-15	14-20
Clutch Housing to Engine Block	7/16-14	40-50	54-67

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SECTION 16-34 Model S5-42 ZF Manual Transmission

SUBJECT	PAGE
ADJUSTMENTS	
Bearing Preload Adjustment	16-34-25
DESCRIPTION	16-34-2
DIAGNOSIS AND TESTING	16-34-2
DISASSEMBLY AND ASSEMBLY	
Transmission	16-34-10
INSPECTION	
Synchronizer Ring/Synchronizer Body Wear Check	16-34-27
REMOVAL AND INSTALLATION	
Rear Oil Seal—4x2 Transmissions	16-34-6
Rear Oil Seal—4x4 and F-Super Duty Series Transmissions	16-34-7
REMOVAL AND INSTALLATION (Cont'd.)	
Transmission (4x2)	16-34-3
Transmission (4x4)	16-34-4
SPECIFICATIONS	16-34-54
SUBASSEMBLIES	
Countershaft	16-34-53
Input Shaft	16-34-52
Mainshaft	16-34-37
Shift Rails	16-34-30
Shift Tower Assembly	16-34-28
Transmission Front Case	16-34-32
Transmission Rear Case	16-34-31
VEHICLE APPLICATION	16-34-1

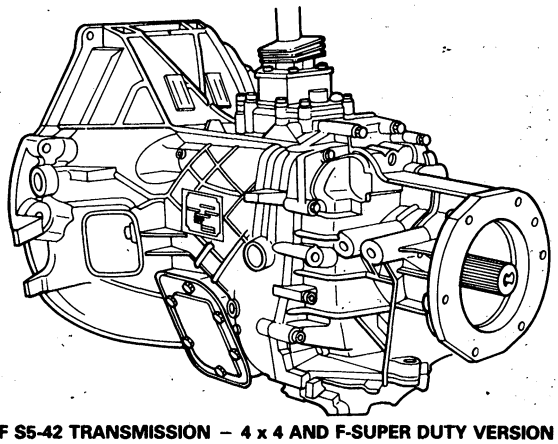
VEHICLE APPLICATION

E-350 Stripped Chassis, F-150—350, F-Super Duty Chassis Cab, Commercial Stripped Chassis and Bronco Vehicles.

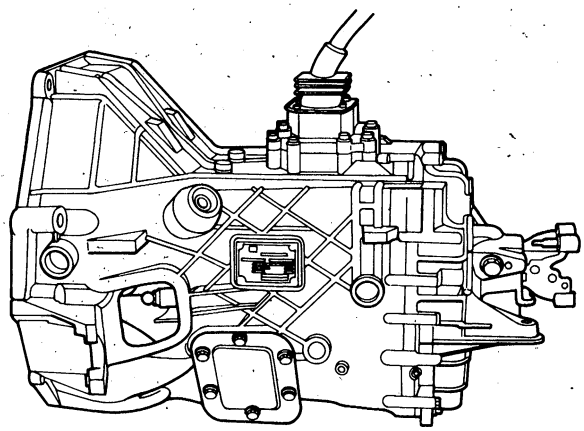
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DESCRIPTION

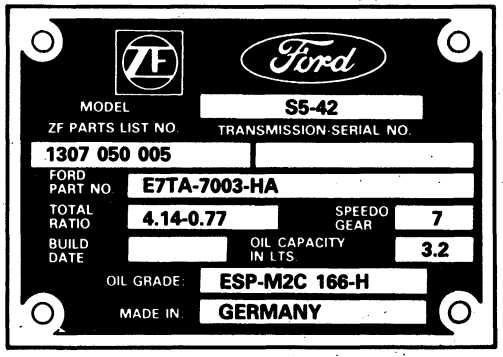
The model number for the ZF Transmission is S 5-42. This model number can be divided into three parts. First, "S" designates a synchronized transmission. Second, "5" designates the number of forward gears. Finally, "42" is the approximate maximum input torque capacity in tens of ft-lbs. In this case 42 equals 420 ft-lbs. input torque capacity.



ZF S5-42 TRANSMISSION – 4 x 4 AND F-SUPER DUTY VERSION



ZFS 5-42 TRANSMISSION – 4 x 2 VERSION



TRANSMISSION IDENTIFICATION PLATE

C8192-2A

The S5-42 ZF Transmission is available in a wide ratio for gasoline engines (7.5L, 5.8L, 4.9L) and a close ratio for diesel engines (7.3L). The ratios are as follows:

	1st	2nd	3rd	4th	5th	Reverse
Close Ratio (Diesel)	4.14	2.37	1.42	1.0	0.77	3.79
Wide Ratio (Gasoline)	5.72	2.94	1.61	1.0	0.76	5.24

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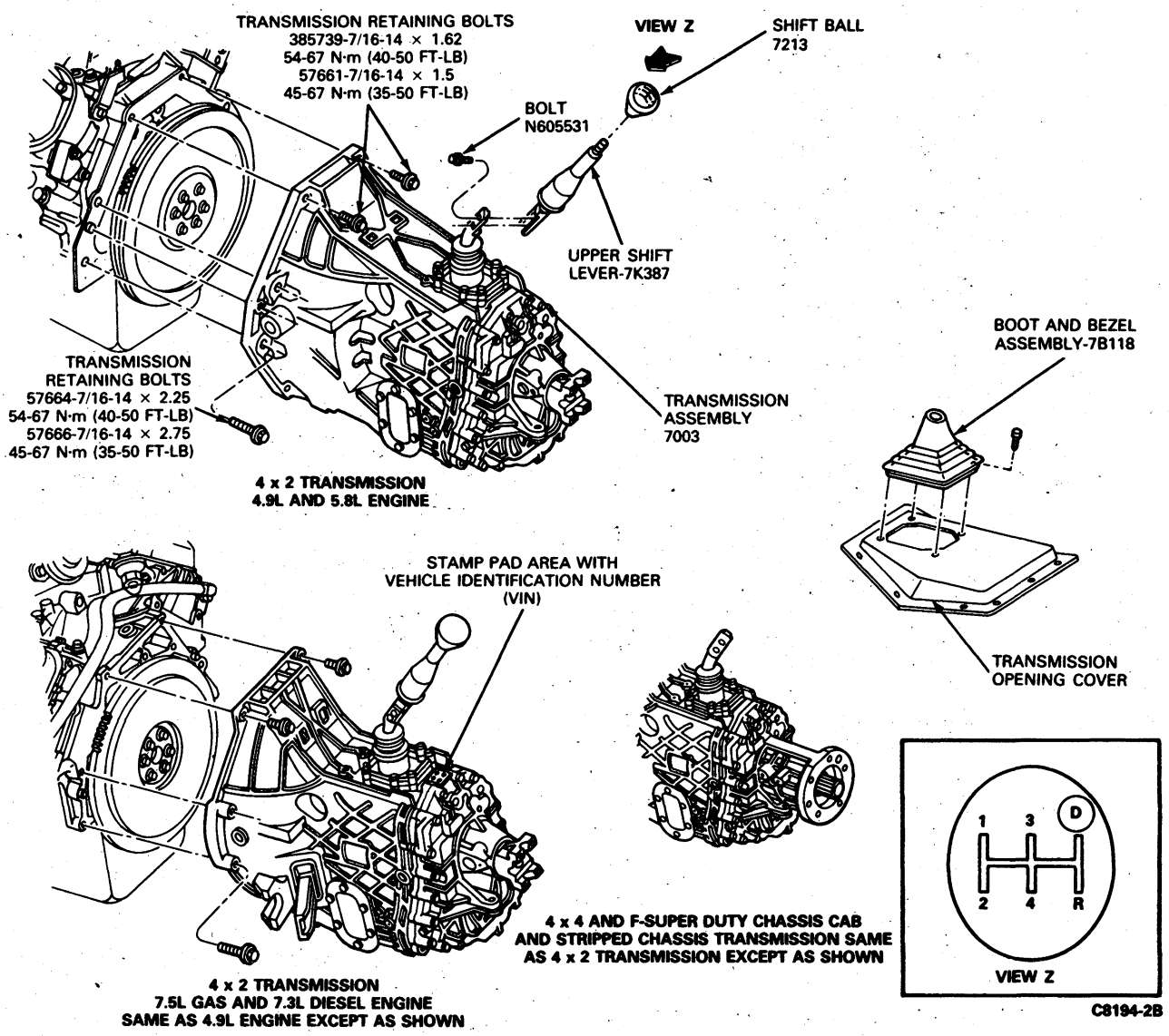
The transmission features an aluminum housing with an integral clutch housing. Because of the aluminum housing, the tapered roller bearings of the transmission shafts must be fitted under preload. This is because heat expansion of the aluminum transmission case is greater than that of the steel alloy mainshaft and countershaft. If the bearings were not pre-loaded, this would result in excessive end play when the transmission case expands in warm, loaded operating conditions. The transmission also features shrink fit gears on the countershaft. Shrink fit gears are connected to the countershaft by friction only, rather than connected to the countershaft through splines. The gear is heated and lightly pressed onto the shaft. The subsequent cooling of the gear provides the shrink fitting. The countershaft is serviced as an assembly.

DIAGNOSIS AND TESTING

For diagnosis and testing procedures, refer to Section 16-10, General Manual Transmission Service. Also refer to Section 16-01, General Clutch Service.

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REMOVAL AND INSTALLATION



Transmission (4x2)

Removal

1. Shift the transmission into neutral.
2. Remove the carpet or floor mat. Refer to Section 45-26, Carpets and Floor Mats, for removal procedure.
3. Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.
4. Remove the two bolts and remove the upper shift lever from the lower shift lever.
5. Raise the vehicle on a hoist and position safety stands under the vehicle.
6. Disconnect the speedometer cable.

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REMOVAL AND INSTALLATION (Continued)

7. Disconnect the back-up lamp switch located at the top left hand side of the transmission.
8. Remove the drain plug and drain the oil from the transmission.
9. Position a transmission jack, such as Rotunda Transmission Jack 077-00008 or equivalent under the transmission.
10. Disconnect the driveshaft and clutch linkage from the transmission and wire it to one side. Refer to Section 15-62, Driveshafts and Section 16-04, Hydraulic Clutch System for detailed procedures.
11. On F-Super Duty series vehicles remove the transmission parking brake from the transmission. Refer to Section 12-70, Parking Brake, for procedure.
12. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember removal and installation in this Section.
13. Remove the bolts that retain the transmission to the engine block.
14. Move the transmission to the rear until the input shaft clears the engine flywheel. Lower the transmission from the vehicle.

Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent. Install guide studs in the front case and raise the transmission until the input shaft splines are aligned with the clutch disc splines. The clutch release bearing and hub must be properly positioned in the release lever fork.
2. Slide the transmission forward on the guide studs until it is in position on the front case. Install the attaching bolts and tighten them to 54-67 N·m (40-50 ft-lb.). Remove the guide studs and install the two remaining attaching bolts.
3. Install the crossmember as described under Crossmember Removal and Installation in this Section. Position the insulator and retainer between the transmission and crossmember. Install bolts and tighten to 60-80 N·m (45-60 ft-lbs). Install the nut retaining the insulator and retainer to crossmember. Tighten to 68-94 N·m (50-70 ft-lbs). Remove the transmission jack.
4. Connect the speedometer cable and driven gear and clutch linkage.
5. Connect the backup lamp switch.
6. On F-Super Duty series vehicles, install the transmission parking brake. Refer to Section 12-70, Parking Brake—Cable Actuated.
7. Connect the driveshaft. Refer to Section 15-62, Driveshaft, for procedure.
8. Fill the transmission with the specified lubricant and lower the vehicle.
9. Install the upper shift lever to the lower shift lever.
10. Install the boot and bezel assembly to the transmission opening cover.
11. Install the upper shift lever to the lower shift lever and tighten the two retaining screws to 22-33 N·m (16-24 ft-lbs.).
12. Install the isolator pad assembly. Install the floor pan cover and floor mat.
13. Install the shift ball on the upper shift lever if removed.

Transmission (4x4)

Removal

1. Shift the transmission into neutral.
2. Remove the carpet or floor mat. Refer to Section 45-26, Carpets and Floor Mats, for removal procedure.
3. Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.
4. Remove the two bolts and remove the upper shift lever from the lower shift lever.
5. Raise the vehicle on a hoist.
6. Remove the drain plugs and drain the transmission and transfer case.
7. Disconnect the rear driveshaft from the transfer case and wire it out of the way. Refer to Section 15-62, Driveshafts.
8. Disconnect the front driveshaft from the transfer case and wire it out of the way. Refer to Section 15-62, Driveshafts.
9. Disconnect the backup lamp switch.
10. Remove the speedometer cable from the transfer case.
11. If equipped, remove the skid pan from beneath the transfer case.
12. Position a transmission jack such as Rotunda Transmission Jack 077-00008, under the transfer case. Remove the six bolts holding the transfer case to the transmission and carefully lower the transfer case from the vehicle, using care to ensure that the transfer case shift lever clears the opening in the floor pan.
13. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember removal and installation in this Section.
14. Remove the bolts that retain the transmission to the engine block.
15. Move the transmission to the rear until the input shaft clears the engine flywheel housing. Lower the transmission from the vehicle.

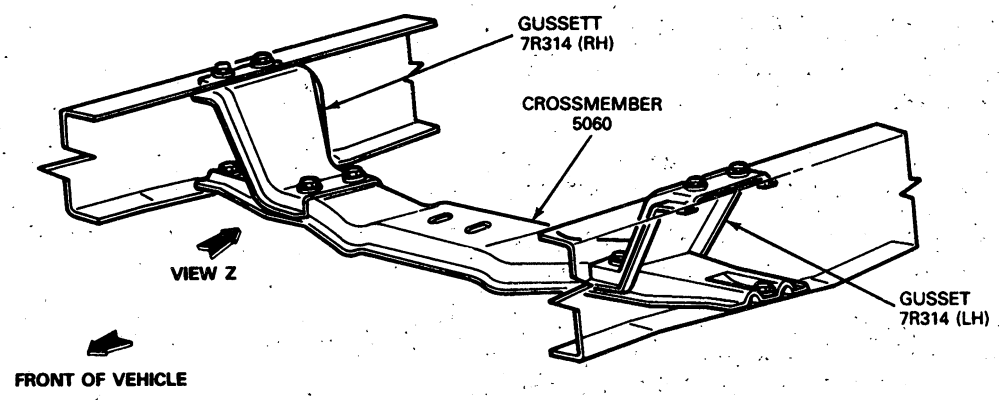
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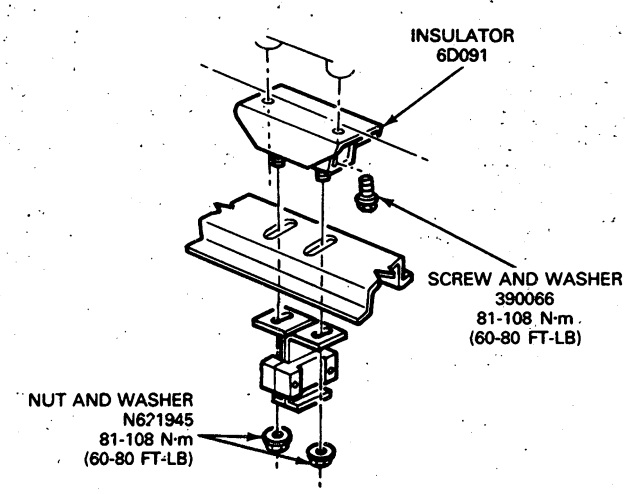
REMOVAL AND INSTALLATION (Continued)

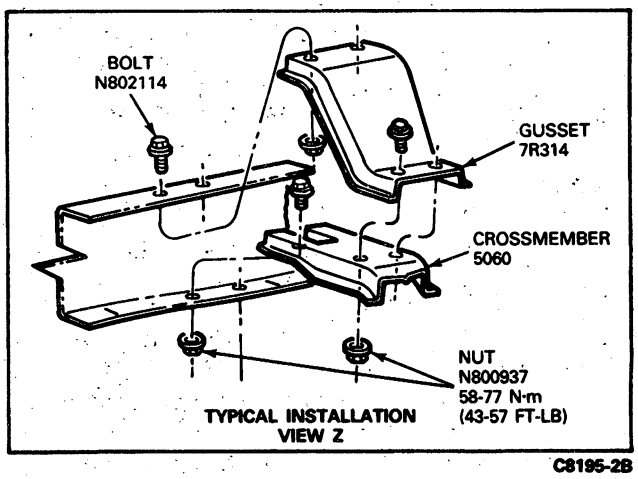
Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent, and install two guide studs in the transmission front case top holes, to guide the transmission into position. Join together the transmission and engine block mating surfaces.
2. Install the two lower bolts and tighten to 54-67 N·m (40-50 ft-lbs). Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the retaining bolts. Refer to crossmember installation in this Section. Tighten the bolts to 60-80 N·m (45-60 ft-lbs.).
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack. Position the transfer case on the transmission, using care to guide the transfer case shift lever through the opening in the floor pan. Install the gasket and six retaining bolts. Tighten the bolts to specifications listed in the appropriate transfer case section in Group 16 in this manual.
6. Install the speedometer cable to the transfer case.
7. Connect the front driveshaft to the transfer case yoke or flange.
8. Connect the rear driveshaft to the transfer case yoke or flange.
9. Fill transfer case and transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or DDX (ESP-M2C166-H) or equivalent.
10. Connect the back-up lamp switch.
11. Lower vehicle.
12. Install the upper shift lever to the lower shift lever. Tighten the retaining bolts to 22-33 N·m (16-24 ft-lbs.).
13. Install the boot and bezel assembly to the transmission opening cover. Install the four retaining screws.
14. Install the isolator pad assembly. Install the floor pan cover and floor mat.
15. Install the shift ball on the upper shift lever and on the transfer case shift lever if removed.

Crossmember







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REMOVAL AND INSTALLATION (Continued)

Removal

1. Raise vehicle on a hoist.
2. Remove skid plate, if so equipped. Remove heat shield from catalytic converter.

CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extremely high temperatures generated by the converter.

3. Remove two nuts connecting upper gusset to frame on both sides of frame.
4. Remove nut and bolt assembly connecting gusset to crossmember. Remove gusset on left side.
5. Remove bolts holding transmission to transmission support plate on crossmember.
6. Raise transmission with a transmission jack.
7. Remove the nut and bolt assemblies connecting the support plate to the crossmember. Remove support plate. Remove right gusset.
8. Remove nut and bolt assemblies connecting crossmember to frame. Remove crossmember.

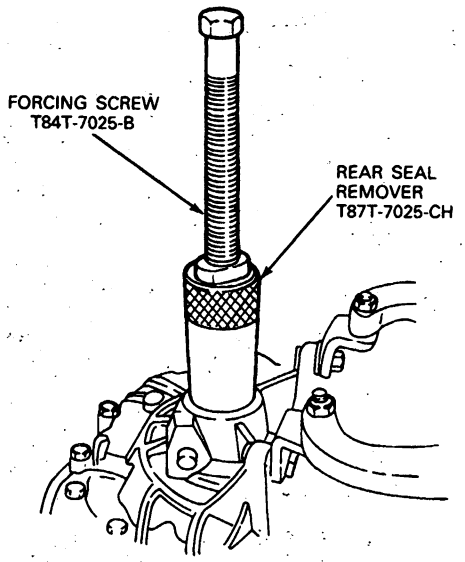
Installation

1. Install crossmember and transmission support plate, and position right and left gussets on bolts on frame. Install nuts on upper gusset to frame bolts and tighten to specification.
2. Install crossmember to frame nut and bolt assembly and tighten to specification.
3. Install nut and bolt assembly connecting gusset to crossmember and tighten to specification.
4. Install nut and bolt assemblies connecting transmission support plate to crossmember and tighten to specification.
5. Lower the transmission.
6. Install bolts connecting transmission support plate to transmission and tighten to specification.
7. Install skid plate, if so equipped. Install heat shield over catalytic converter. Tighten all nuts and bolts to specification.

Rear Oil Seal—4x2 Transmissions

Removal

1. Disconnect the driveshaft from the output flange. Refer to Section 15-62, Driveshaft.
2. Using a chisel, bend back the tab on the output flange retaining locknut.
3. Attach Companion Flange Holding Tool T78P-4851-A or equivalent to the transmission output flange with four hex bolts.
4. Loosen the hex nut that holds the output flange to the mainshaft with Socket T87T-7025-AH. Remove the flange holding tool after loosening the nut.
5. Remove the output flange from the output end of the mainshaft.
6. Insert Rear Seal Remover T87T-7025-CH or equivalent over output end of mainshaft and tighten into rear seal.
7. Assemble Forcing Screw T84T-7025-B or equivalent into seal remover. Turn forcing screw while holding seal remover to pull seal.



4 x 2 OUTPUT SEAL REMOVAL

C8196-1A

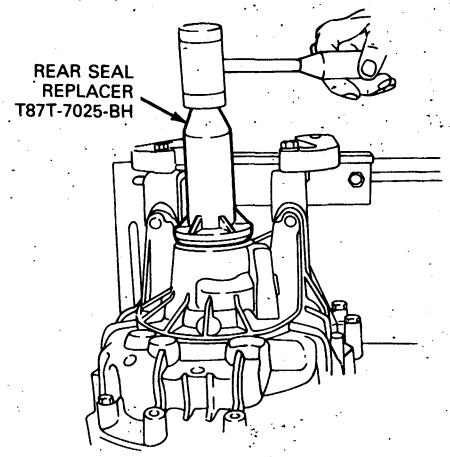
Installation

1. Position the output shaft seal on Output Seal Replacer T87T-7025-LH or equivalent and position the seal and tool over the output end of the mainshaft.
2. Using a soft hammer gently tap the seal in until it seats in the opening. Apply a little liquid soap around the circumference to minimize friction.
3. Install the output flange on the output end of the mainshaft.
4. Attach Companion Flange Holding Tool T78P-4851-A or equivalent to the transmission output flange with four hex bolts.
5. Install the hex nut that holds the output flange to the mainshaft with Socket T87T-7025-AH. Tighten the nut to 250 N·m (184 ft-lbs.). Remove the flange holding tool after tightening the nut.
6. Using a chisel, bend over the tab on the output flange retaining nut.

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REMOVAL AND INSTALLATION (Continued)

7. Connect the driveshaft to the output flange. Refer to Section 15-62, Driveshaft.



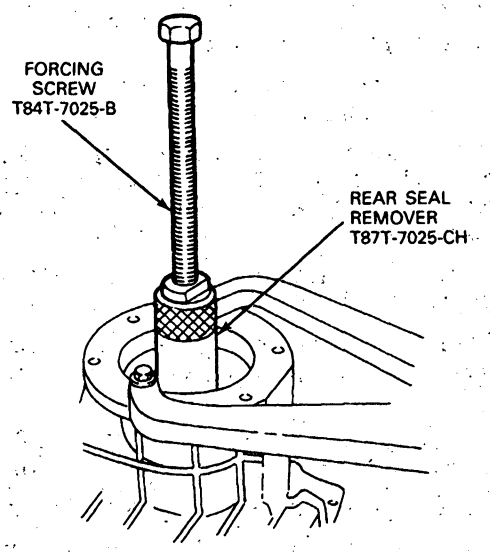
4 x 2 TRANSMISSION REAR OIL SEAL INSTALLATION

C8199-1A

Rear Oil Seal—4x4 and F-Super Duty Series Transmissions

Removal

1. On 4x4 vehicles, remove the transfer case as described in the appropriate transfer case section in Group 16 in this manual. On F-Super Duty series vehicles, remove the transmission mounted parking brake as described in Section 12-70, Parking Brake.
2. Insert Rear Seal Remover T87T-7025-CH or equivalent over output end of mainshaft and tighten into rear seal.
3. Assemble Forcing Screw T84T-7025-B or equivalent into seal remover. Turn forcing screw while holding seal remover to pull seal.

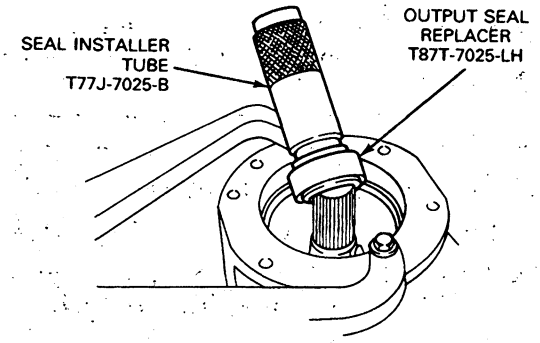


4 x 4 OUTPUT SEAL REMOVER

C8198-1A

Installation

1. Place a new oil seal and Output Seal Replacer T87T-7025-LH or equivalent over the output end the mainshaft.
2. Slide Puller Tube T77J-7025-B or equivalent over the output end of the mainshaft.
3. Using a soft hammer, gently tap the seal into place.
4. On 4x4 vehicles, install the transfer case as described in the appropriate transfer case section in Group 16 in this manual. On F-Super Duty vehicles, install the transmission mounted parking brake as described in Section 12-70, Parking Brake.

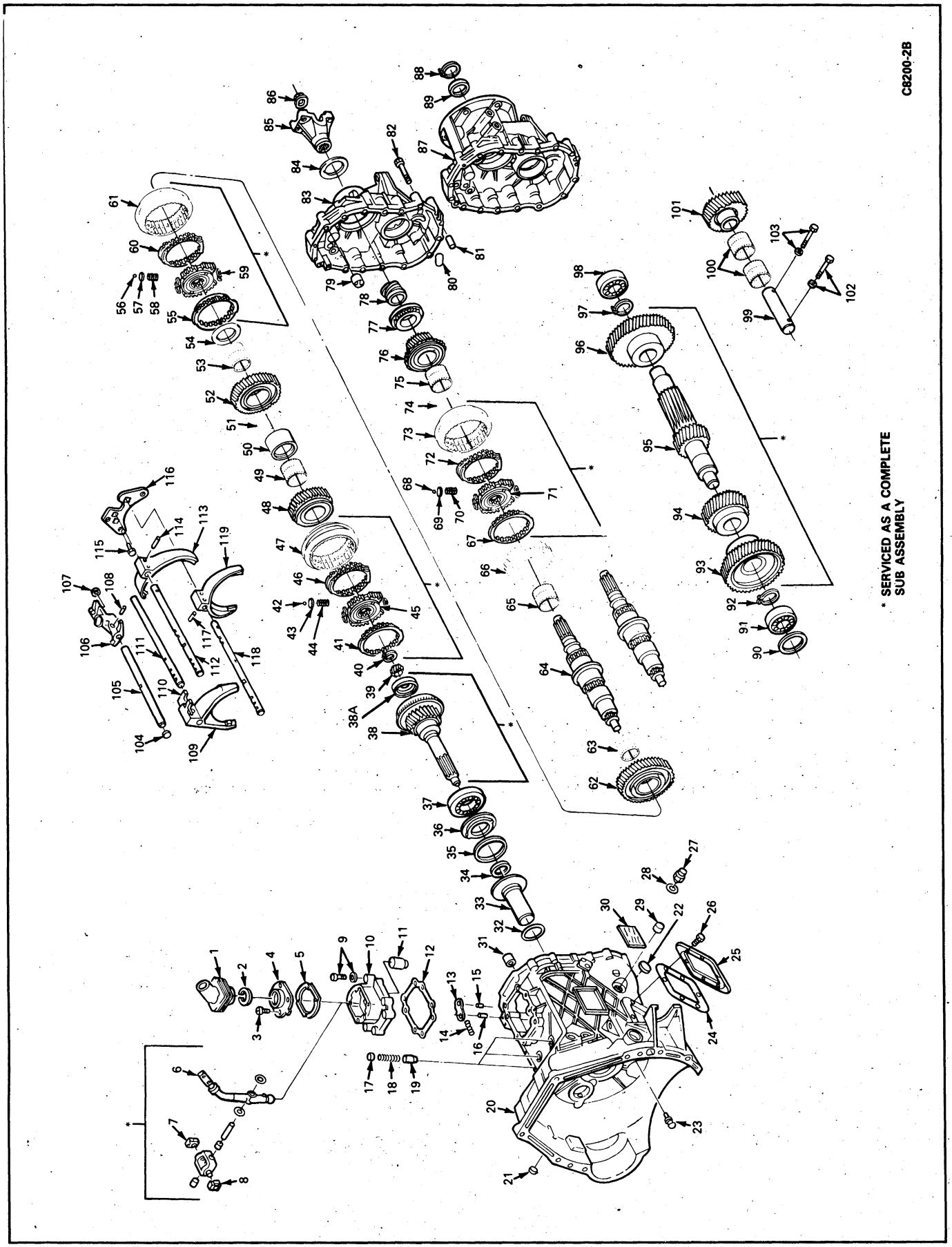


4 x 4 TRANSMISSION REAR OIL SEAL INSTALLATION

C8197-1A

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DISASSEMBLY AND ASSEMBLY



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LEGEND

NO.	DESCRIPTION
1.	SHIFT LEVER BOOT
2.	SNAP RING
3.	CAPSCREW
4.	SHIFT TOWER COVER
5.	GASKET
6.	LOWER SHIFT LEVER
7.	GUIDE PIECE
8.	GUIDE PIECE
9.	HEX BOLTS
10.	SHIFT HOUSING
11.	SHIFT DETENT
12.	GASKET
13.	5TH-REVERSE INTERLOCK
14.	INTERLOCK SPRING
15.	INTERLOCK ROLL PIN
16.	INTERLOCK ROLL PIN
17.	SEALING CAP
18.	SPRING
19.	SHIFT RAIL DETENT
20.	FRONT CASE
21.	SEALING CAP
22.	PLUG – DRAIN
23.	BOLT
24.	GASKET
25.	PTO COVER
26.	BOLT
27.	BACKUP LAMP SWITCH
28.	SEALING RING
29.	PLUG – FILLER
30.	ID PLATE
31.	CENTRAL SHIFT RAIL BEARING
32.	O-RING
33.	QUILL
34.	OIL SEAL
35.	SHIM
36.	BAFFLE
37.	INPUT SHAFT BEARING
38.	INPUT SHAFT
39.	MAINSHAFT BEARING
40.	SNAP RING
41.	4TH GEAR SYNCHRONIZER RING
42.	BALL
43.	PRESSURE PIECE
44.	SPRING
45.	3RD-4TH SYNCHRONIZER BODY
46.	3RD GEAR SYNCHRONIZER RING
47.	3RD-4TH SLIDING SLEEVE
48.	3RD GEAR
49.	CAGED NEEDLE ROLLERS
50.	BEARING RACE
51.	THRUST WASHER
52.	2ND GEAR
53.	CAGED NEEDLE ROLLERS
54.	SNAP RING
55.	2ND GEAR SYNCHRONIZER RING
56.	BALL
57.	PRESSURE PIECE
58.	SPRING
59.	1ST-2ND SYNCHRONIZER BODY
60.	1ST GEAR SYNCHRONIZER RING
61.	1ST-2ND SLIDING SLEEVE
62.	1ST GEAR
63.	NEEDLE ROLLERS
64.	MAINSHAFT
65.	CAGED NEEDLE ROLLERS
66.	REVERSE GEAR
67.	REVERSE GEAR SYNCHRONIZER RING
68.	BALL
69.	PRESSURE PIECE
70.	SPRING
71.	5TH-REVERSE SYNCHRONIZER BODY
72.	5TH GEAR SYNCHRONIZER RING
73.	5TH-REVERSE SLIDING SLEEVE
74.	SNAP RING
75.	CAGED NEEDLE ROLLERS
76.	5TH GEAR
77.	MAINSHAFT BEARING
78.	SPEEDOMETER DRIVE GEAR (4 x 2 ONLY)
79.	CENTRAL SHIFT RAIL BEARING
80.	MAGNET
81.	DOWEL
82.	BOLT
83.	REAR CASE (4 x 2)
84.	REAR OIL SEAL (4 x 2)
85.	OUTPUT YOKE (4 x 2)
86.	LOCKNUT (4 x 2)
87.	REAR CASE (4 x 4)
88.	SNAP RING (4 x 4)
89.	OIL SEAL (4 x 4)
90.	SHIM
91.	FRONT COUNTERSHAFT BEARING
92.	SNAP RING
93.	COUNTERSHAFT DRIVE GEAR
94.	COUNTERSHAFT 3RD GEAR
95.	COUNTERSHAFT
96.	COUNTERSHAFT 5TH GEAR
97.	SNAP RING
98.	COUNTERSHAFT REAR BEARING
99.	REVERSE IDLER SHAFT
100.	CAGED NEEDLE ROLLERS
101.	REVERSE IDLER GEAR
102.	SCREW AND SEALING RING
103.	SCREW AND SEALING RING
104.	PLUG
105.	CENTRAL SHIFT RAIL
106.	SHIFT FINGER
107.	PLUG
108.	ROLL PIN
109.	ROLL PIN
110.	SHIFT FORK
111.	SHIFT RAIL
112.	SHIFT RAIL
113.	SHIFT FORK
114.	ROLL PIN
115.	BOLT
116.	INTERLOCK PLATE
117.	ROLL PIN
118.	SHIFT RAIL
119.	SHIFT FORK

C9030-2A

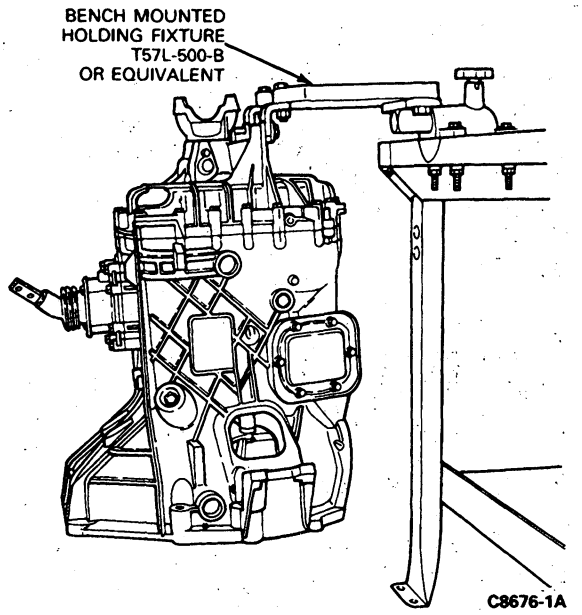
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DISASSEMBLY AND ASSEMBLY (Continued)

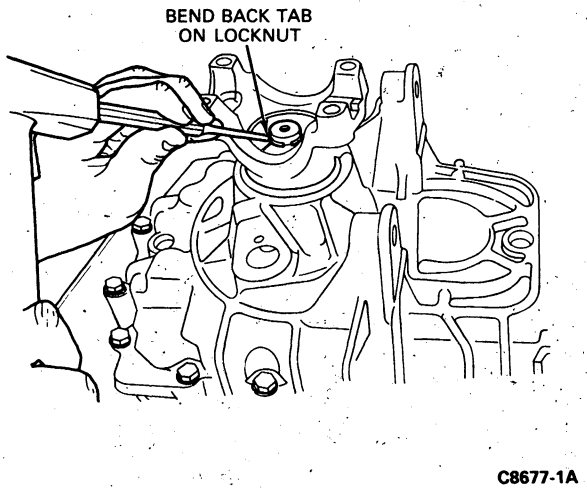
Transmission

Disassembly

1. Attach the transmission to the Bench Mounted Holding Fixture T57L-500-B or equivalent. Place the transmission in a vertical position with the front case pointing downward.

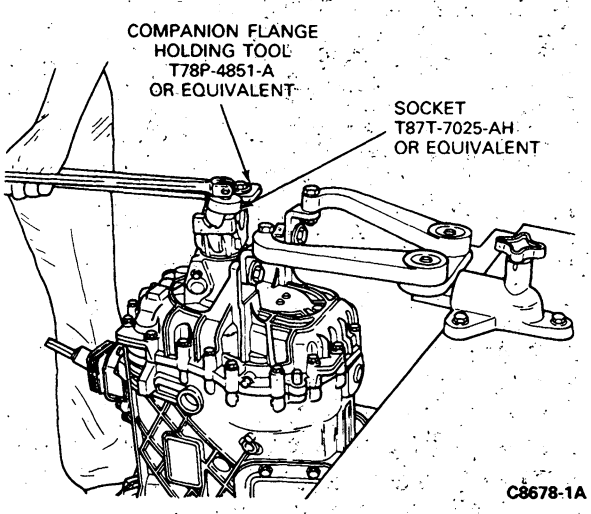


2. Using a chisel, bend back the tab on the output flange retaining locknut.

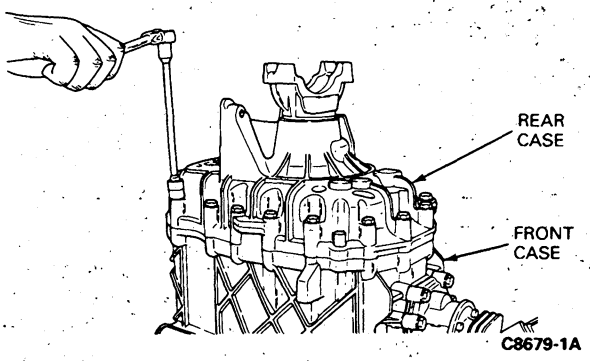


3. Attach Companion Flange Holding Tool T78P-4851-A or equivalent to the transmission output flange.
4. Loosen the hex nut that holds the output flange to the mainshaft with Thin-Walled Socket T87T-7025-AH or equivalent. Remove the flange holding tool after loosening the nut.

CAUTION: Do not remove the hex nut or output flange at this time.



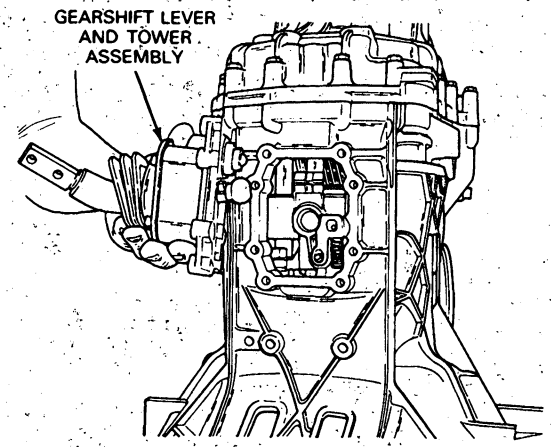
5. Remove 15 of the 17 8mm hex head screws that hold the front and rear cases together. Leave two screws at opposite sides of the case installed.
6. Remove any power take-off equipment installed on the transmission.



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DISASSEMBLY AND ASSEMBLY (Continued)

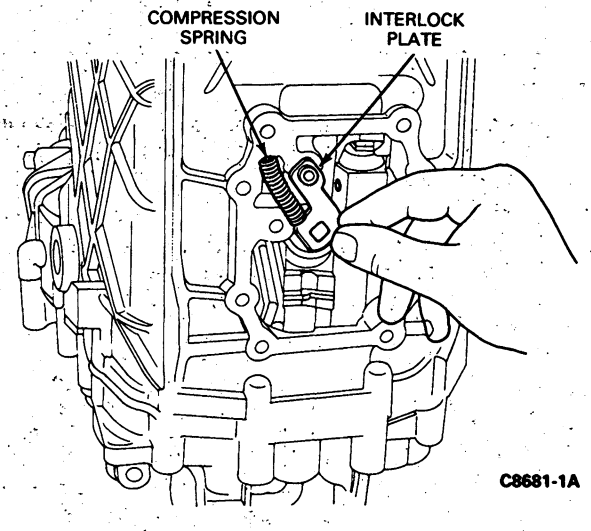
7. Remove the eight 8mm hex bolts that attach the shift tower assembly to the front case. Remove the complete gearshift lever and tower as an assembly.



C8680-1A

8. Remove the interlock plate and compression spring which serves as a reverse gear interlock.

CAUTION: Use care to ensure that parts do not inadvertently fall into transmission.

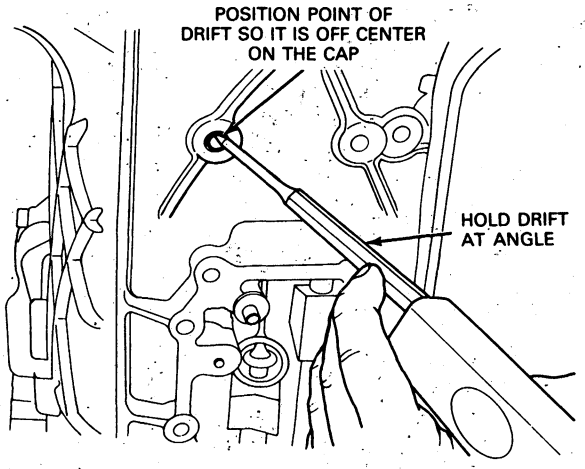


C8681-1A

9. Place a drift punch against the detent bolt sealing cap. Hold the drift at an angle. Position the point of the drift punch so it is off center on the cap. Drive the cap inward until spring pressure against its underside forces the cap out of its hole. Repeat this procedure for the other two detent bolt sealing caps in the front case.

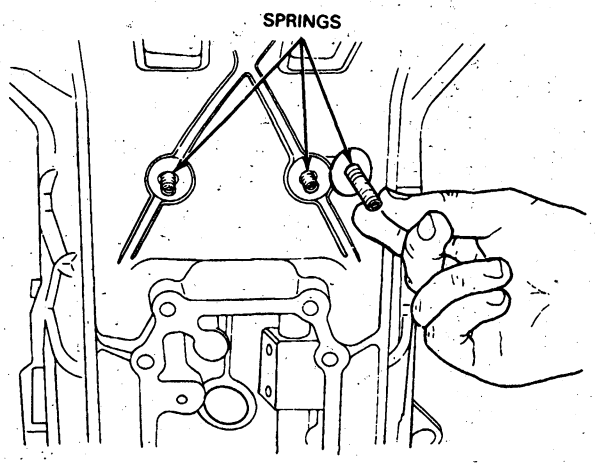
NOTE: Discard removed caps and replace with new sealing caps.

WARNING: CAP IS UNDER SPRING PRESSURE. ALWAYS WEAR PROTECTIVE EYEGLASSES WHEN PERFORMING THIS PROCEDURE TO ENSURE THAT CAP DOES NOT STRIKE EYES WHEN IT IS FORCED OUT BY SPRING PRESSURE.



C8682-1A

10. Remove the springs that are now protruding from the sealing cap holes.

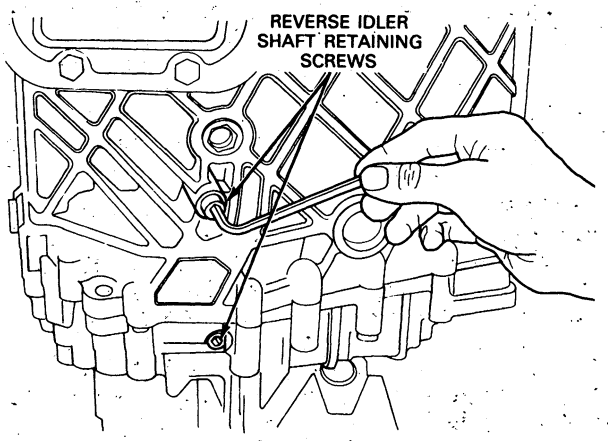


C8683-1A

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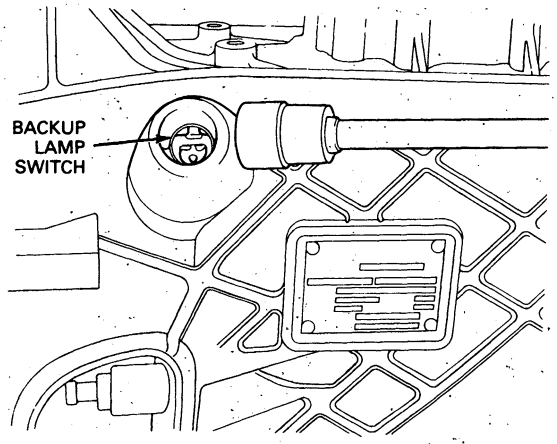
DISASSEMBLY AND ASSEMBLY (Continued)

11. Drive out the sealing caps for the two reverse idler shaft cap screws. Remove the reverse idler shaft cap screws.



C8684-1A

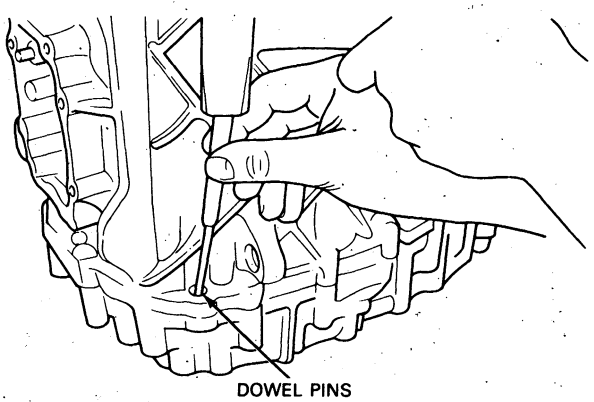
12. If required, remove the backup lamp switch, located above and slightly forward of the transmission nameplate. Remove the backup lamp switch sealing ring.



C8685-1A

13. Use a suitable punch to remove the two dowel pins from the two upper corners of the rear case to front case mating surfaces. Drive them out toward the rear of the transmission.
14. Remove the two remaining hex bolts from the rear case.

NOTE: The transmission input shaft is facing upward during this operation.



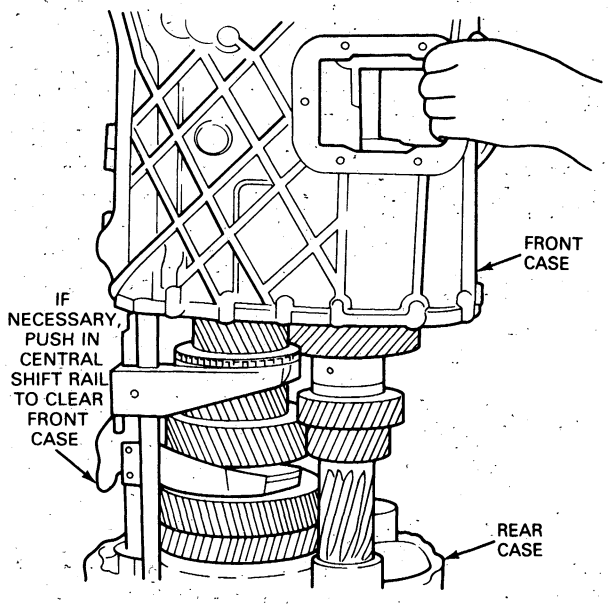
C8687-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

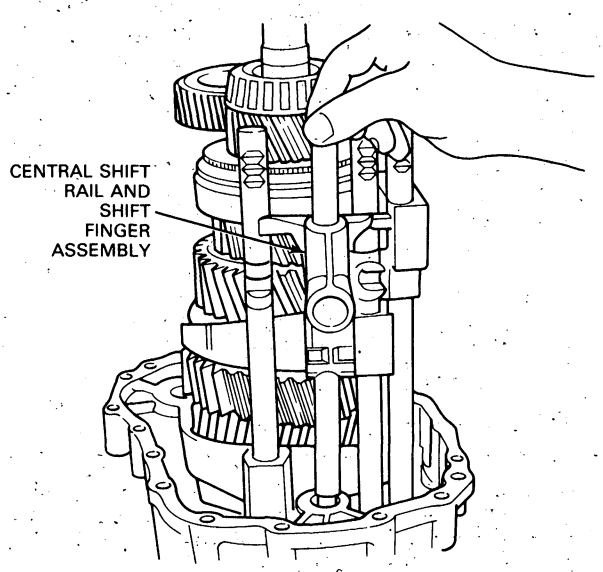
15. Carefully lift the front case off of the rear case. It may be necessary to push the central shift rail inwards to prevent it from "hanging up" on the front case as it is being removed. Use care to ensure that the central shift rail is not lifted off together with the front case. Refer to Subassemblies in this Section for Front Case disassembly and assembly procedures.

CAUTION: The mating surfaces of the two housing assemblies are coated with an adhesive sealing agent. If it is difficult to separate the two housings because of this adhesive, carefully tap the front of the front case with a soft hammer until the bond is loosened. Never use a prying device, such as a screwdriver or chisel, to force the housings apart. It could damage the surface and cause leaks.



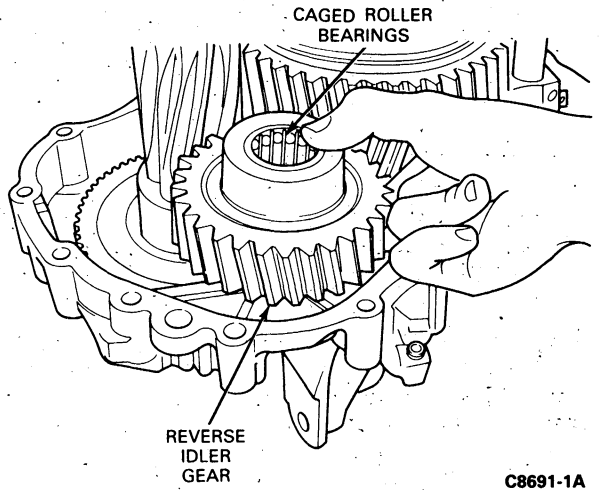
C8688-1A

16. Remove the central shift rail and shift finger assembly.



C8689-1A

17. Lift the shaft out of the reverse idler gear, and remove the gear and two caged roller bearings from the rear case.

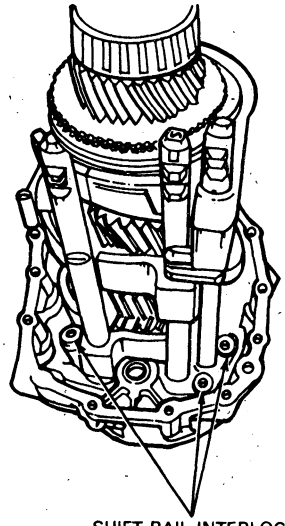


C8691-1A

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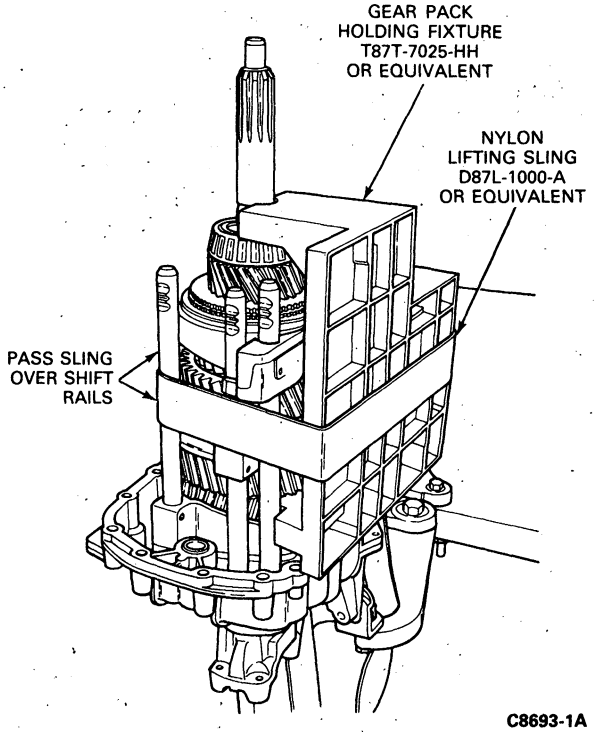
DISASSEMBLY AND ASSEMBLY (Continued)

18. Remove the three capscrews that retain the shift interlock to the rear case.



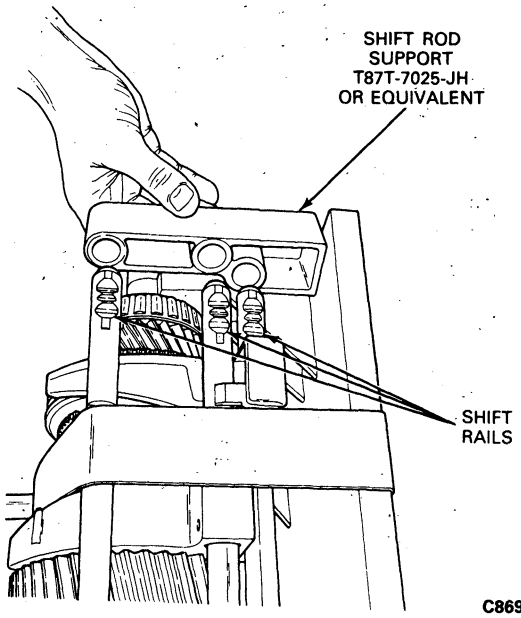
C8692-1A

19. With the transmission in a vertical position, use Nylon Lifting Sling D87L-1000-A or equivalent to strap Gear Pack Holding Fixture T87T- 7025-HH or equivalent to the mainshaft and output shaft assemblies. Pass the sling over the shift rails.



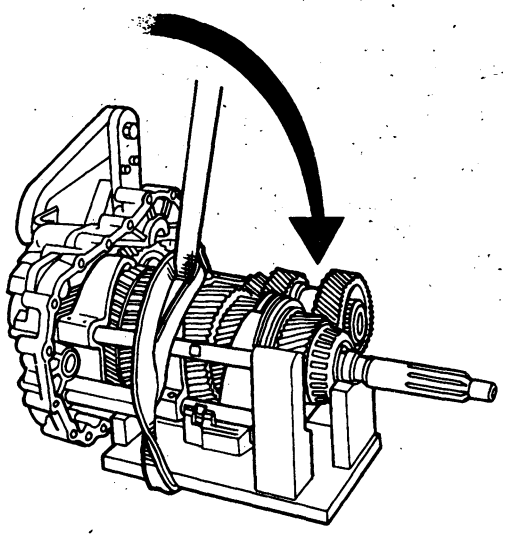
C8693-1A

20. Place the Shift Rod Support, T87T-7025-JH or equivalent over the ends of the shift rails.



C8694-1A

21. Carefully rotate the transmission, together with the gear pack holding fixture, into a horizontal position with the holding fixture beneath the gear pack.

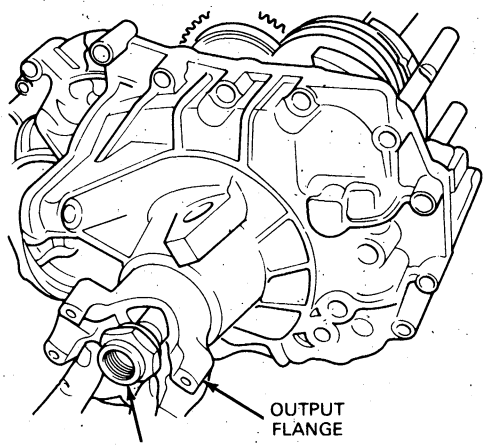


C8695-1A

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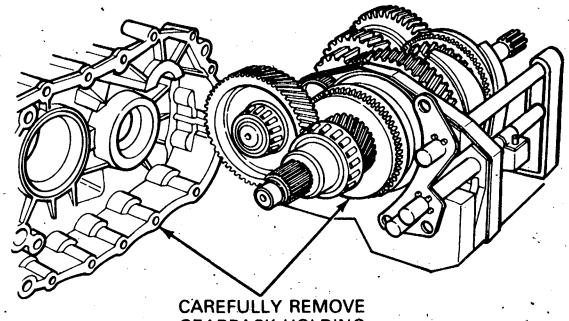
DISASSEMBLY AND ASSEMBLY (Continued)

22. Remove the output shaft flange retaining nut from the output shaft. Remove the flange from the output shaft. If the flange is difficult to remove, tap it loose with a hammer.



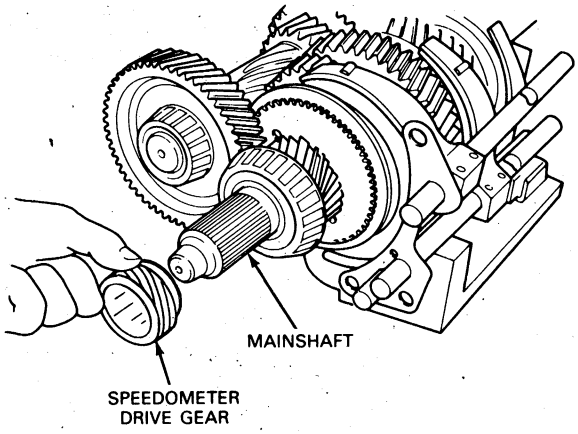
C8696-1A

23. Carefully pull the gearpack and shift rails and their holding fixtures forward to dislodge them from the rear case. Place this assembly on a workbench.



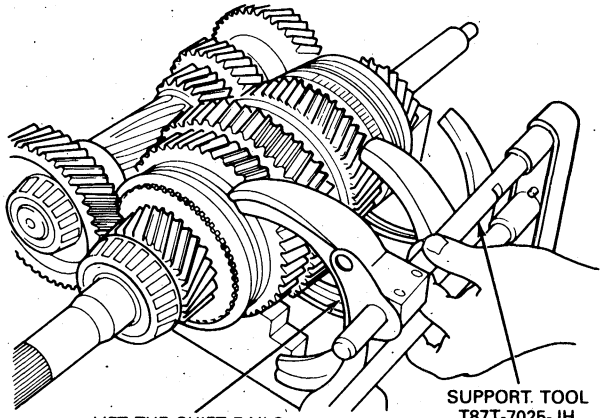
C8697-1A

24. If equipped, remove the speedometer drive gear from the mainshaft.



C8698-1B

25. Remove the sling from around the shift rails, gearpack, and holding fixture.
26. Turn the gearshift rails approximately 45° to release them from the shift hubs. Lift the gearshift rails, forks and interlock, together with support Tool T87T-7025-JH, off the mainshaft.

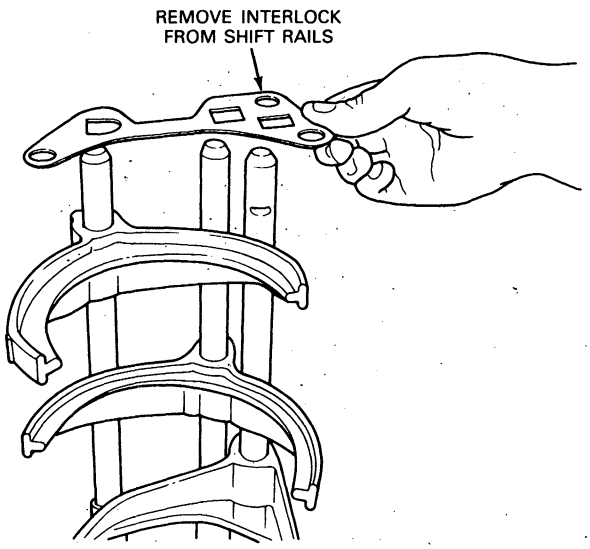


C8699-1A

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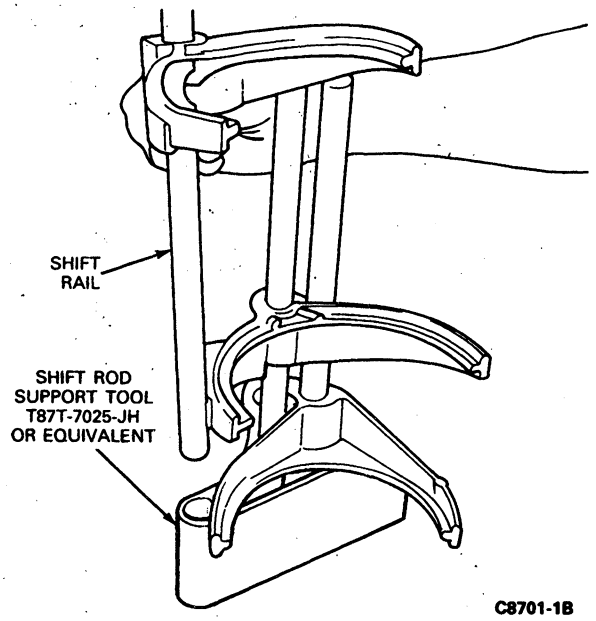
DISASSEMBLY AND ASSEMBLY (Continued)

27. Using the shift rod support tool as a base, set the shift rail assembly on a workbench with the shift rails in a vertical position. Remove the interlock.



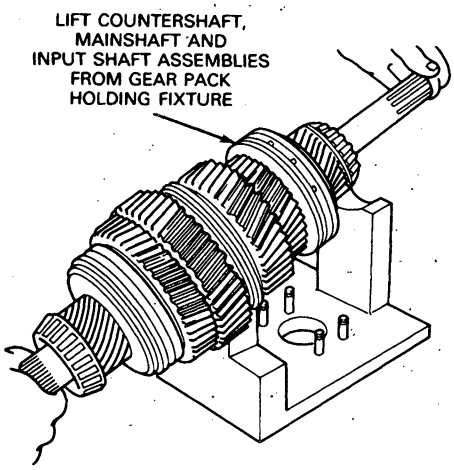
C8700-1A

28. Mark each shift fork, shift rail, and position in the holding fixture to make reassembly easier. Lift the shift rails from the support tool. Refer to Subassemblies in this Section for shift rail disassembly procedures.



C8701-1B

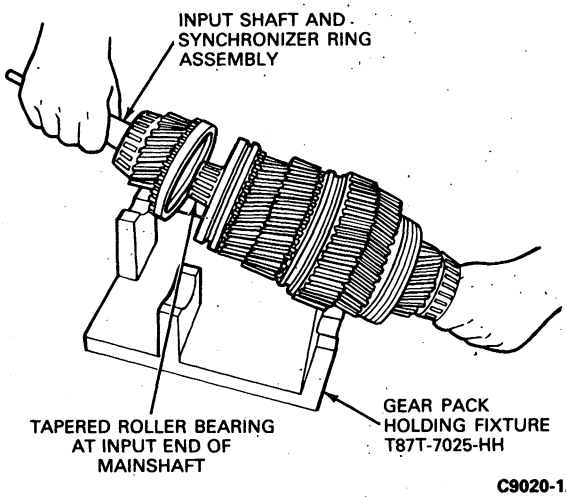
29. Lift the countershaft off the bench stand. Separate the input shaft from the mainshaft. Lift the mainshaft from the stand. Refer to Subassemblies in this Section for mainshaft, countershaft and input shaft disassembly and assembly procedures.
30. Remove the rear cover from the holding fixture. Refer to Subassemblies in this Section for rear case disassembly and assembly procedures.



C8702-1A

Assembly

1. Place the input shaft and synchronizer ring assembly over the tapered roller bearing on the input end of the mainshaft.

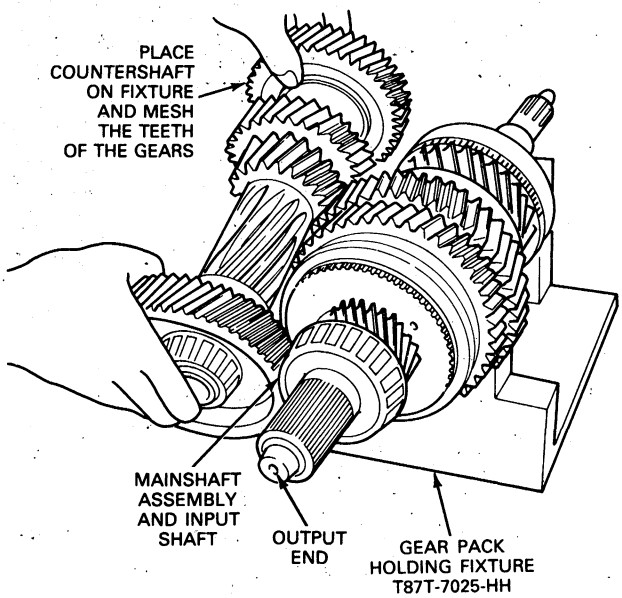


C9020-1A

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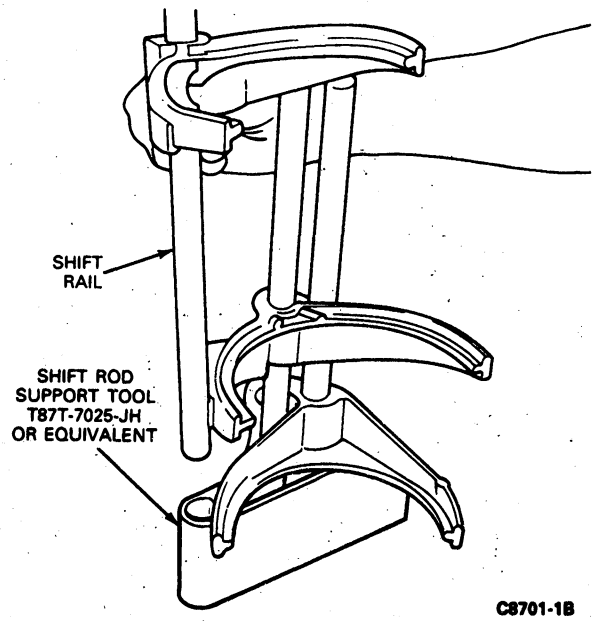
DISASSEMBLY AND ASSEMBLY (Continued)

2. Place the mainshaft and input shaft on the Gear Pack Holding Fixture, T87T-7025-HH or equivalent. Place the countershaft on the fixture and mesh the gears of the two shafts.



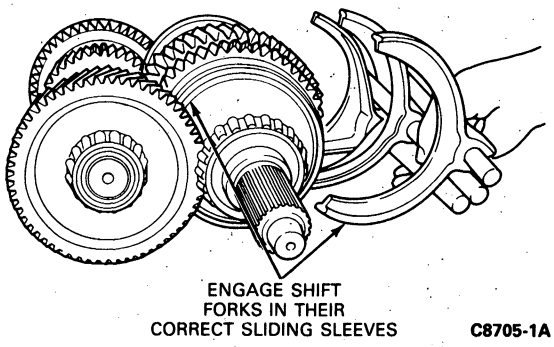
C8704-1A

3. Place the three shift rails and fork assemblies into the Shift Rod Support Tool T87T-7025-HJ or equivalent in the position from which they were removed during disassembly.



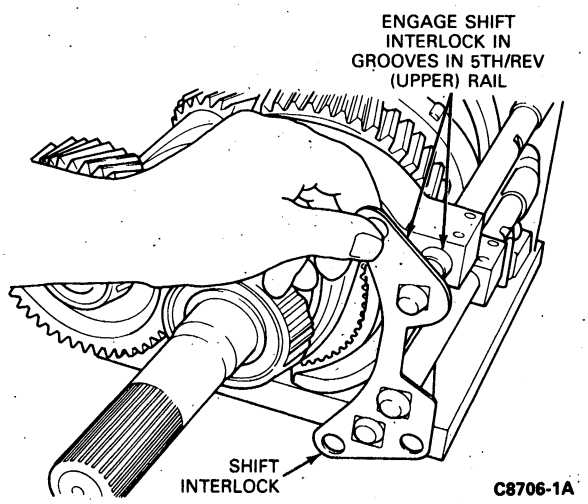
C8701-1B

4. Position the three shift rail assemblies together with the shift rod support tool and interlock so that the shift forks engage in the correct mainshaft sliding sleeves.



C8705-1A

5. Place the shift interlock on the three gearshift rails and engage it in the interlock grooves in the 5th-reverse (upper) rail.

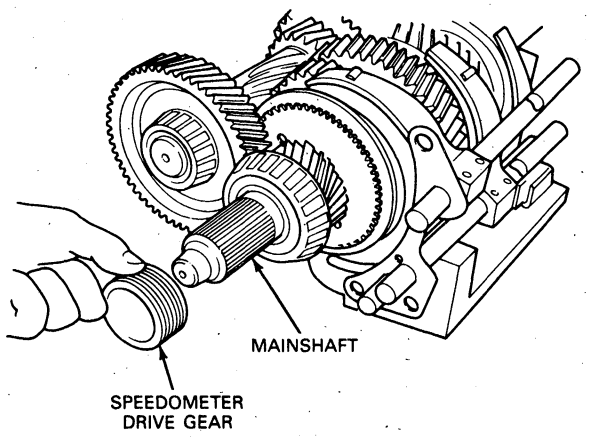


C8706-1A

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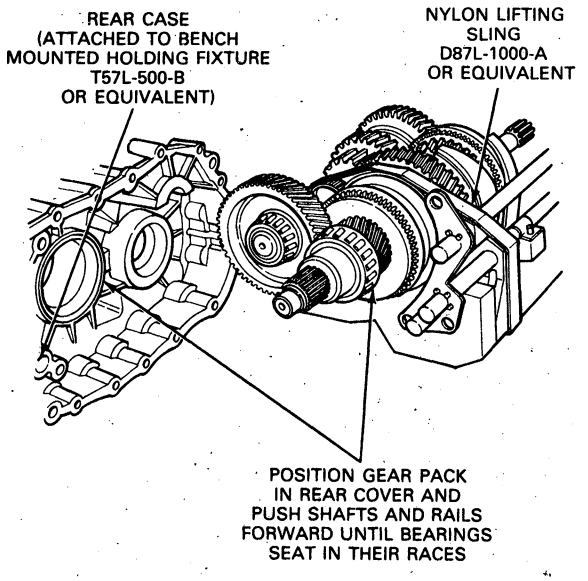
DISASSEMBLY AND ASSEMBLY (Continued)

6. If equipped, slide the speedometer worm gear onto the mainshaft until it seats against the stop on the mainshaft.



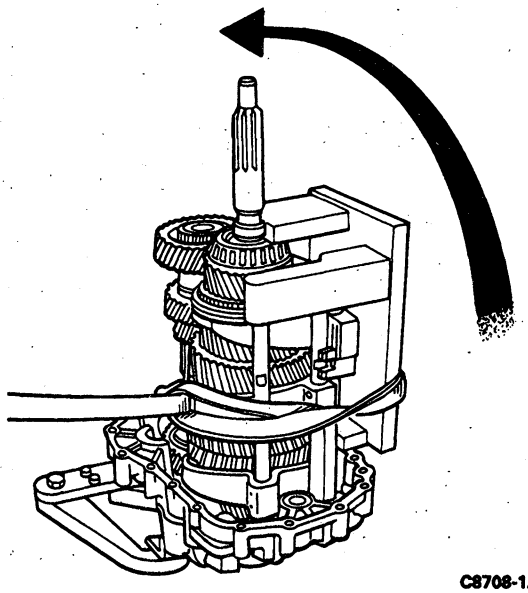
C8698-1A

7. Secure the rear case into the bench mounted holding fixture T57L-500-B or equivalent.
8. Position Nylon Lifting Sling, D87L-1000-A or equivalent around the shift rails, the holding fixture and the mainshaft and countershaft. Position the gear pack into the rear case and push the shafts and rails forward until the bearings seat in their outer races in the housing and the gearshift rails slide into their retaining holes in the housing.



C8707-1A

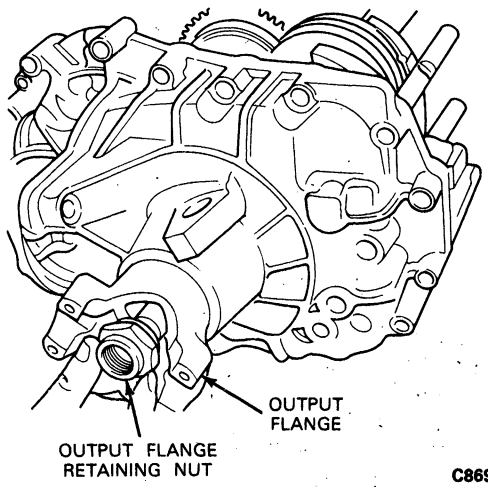
9. Rotate the gear pack and rear case upwards 90° so it is in a vertical position with the input shaft pointing upwards.



C8708-1A

10. If equipped, slide the output flange onto the output end of the mainshaft until it seats against its stop. Screw the hex nut onto the shaft until it is finger-tight.

CAUTION: Use care to ensure that the mainshaft bearing is not pushed off its race when the flange is installed.

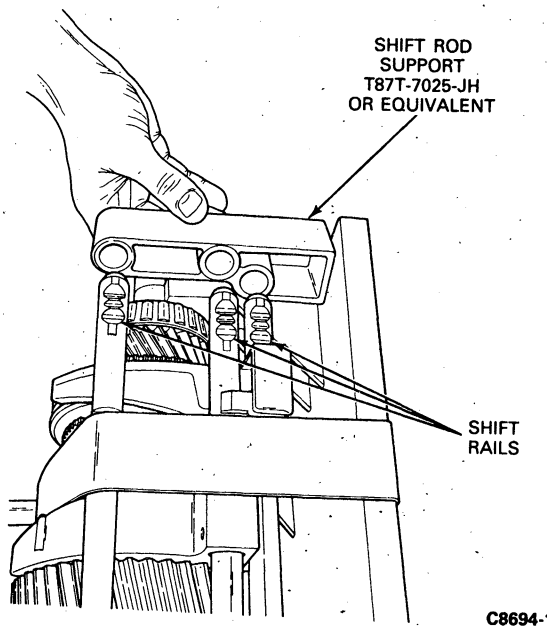


C8696-1A

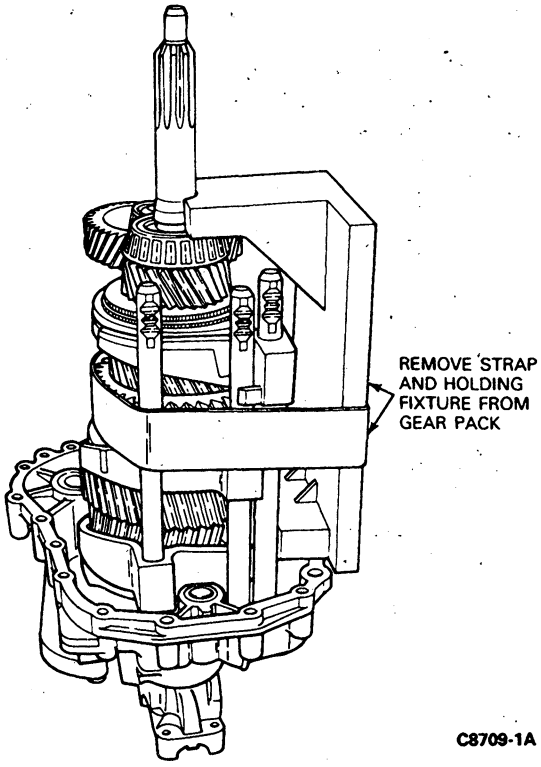
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DISASSEMBLY AND ASSEMBLY (Continued)

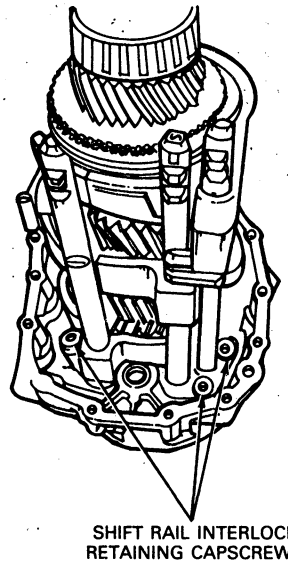
11. Remove the shift rod support tool from the ends of the shift rails.



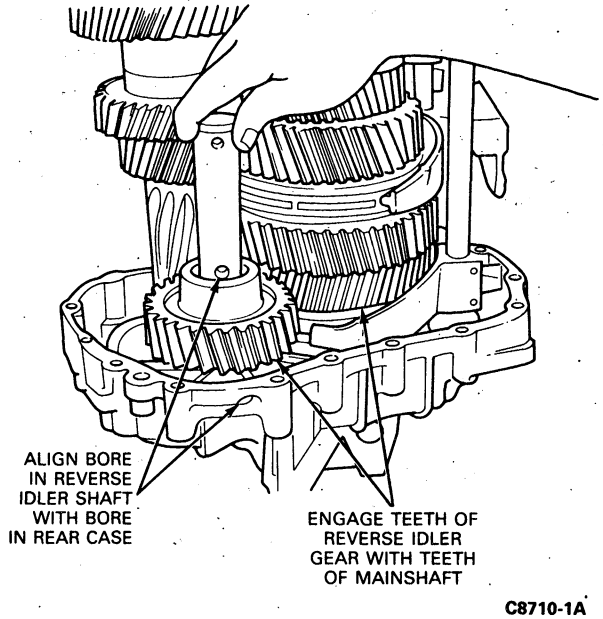
12. Remove the strap and remove the gear pack holding fixture from the mainshaft and countershaft.



13. Attach the three cap screws that secure the shift interlock to the rear transmission housing. Tighten them to 10 N·m (7 ft-lbs). Be sure that the interlock moves freely after tightening the screws.



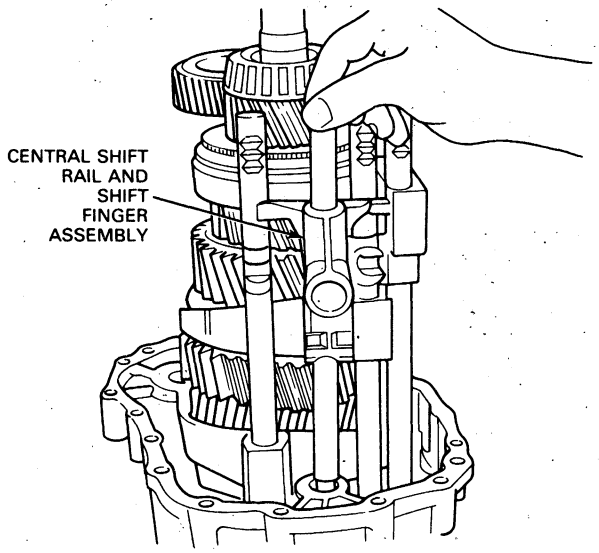
14. Engage the teeth of the reverse idler gear with the reverse gear on the mainshaft. Slide the reverse idler shaft downward through the bearings and into the rear case. Align the lower of the two threaded holes in the shaft with the bore in the rear case. Place a sealing ring on the capscrew and attach the screw through the bore in the housing into the shaft. Tighten the screw finger-tight.



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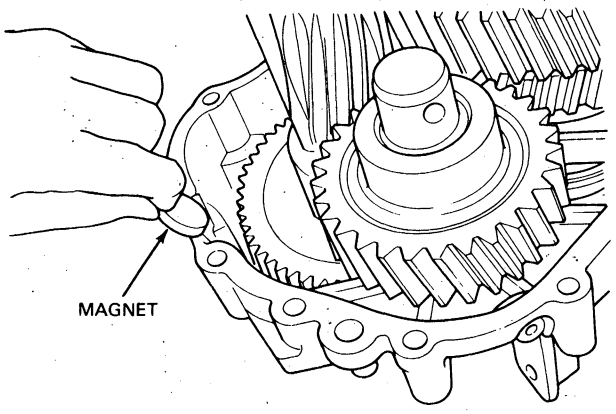
DISASSEMBLY AND ASSEMBLY (Continued)

15. Insert the central shift rail and finger assembly into its bore in the rear case.



C8689-1A

16. If the magnet was removed during disassembly, insert it in the recess in the housing.



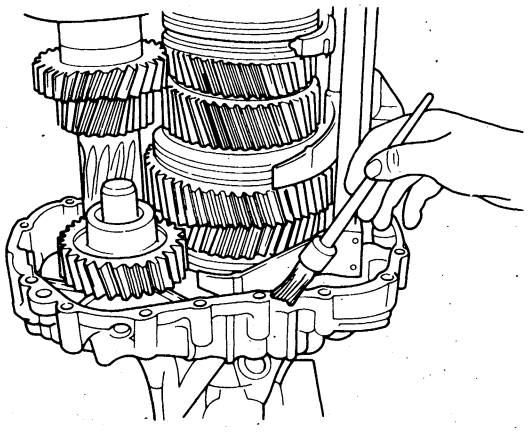
C8711-1A

17. If the tapered roller bearings on the mainshaft, input shaft or countershaft do not have to be adjusted, thinly coat the sealing surface of the rear case with Gasket Maker E2AZ-19562-B (ESE-M4G234-A2) or equivalent.

NOTE: Do not wait longer than ten minutes to tighten all 17 bolts, due to the rapid curing time of the sealant.

CAUTION: Do not use silicon Sealing Compound or equivalent.

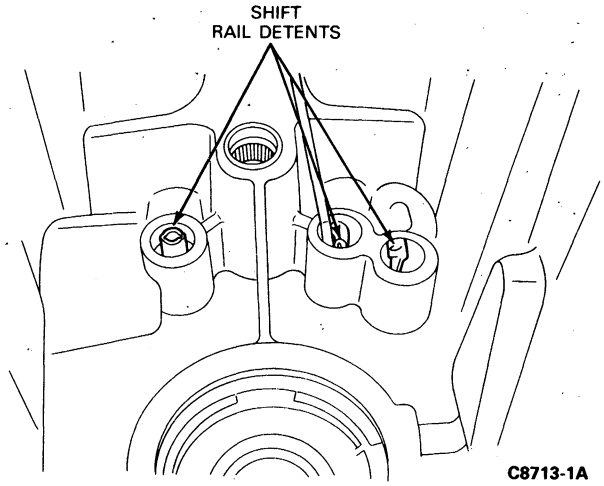
NOTE: The tapered roller bearings preload should be adjusted if either the front or rear cases, countershaft, mainshaft, input shaft, or a bearing has been replaced. If the tapered roller bearings on the mainshaft, input shaft, or countershaft have to be adjusted, do not apply the sealant at this time.



C8712-1A

18. If removed, push the three shift rail detents back into their holes in the front case.

CAUTION: Use care to ensure that the shift rail detents do not obstruct entry of the shift rails.



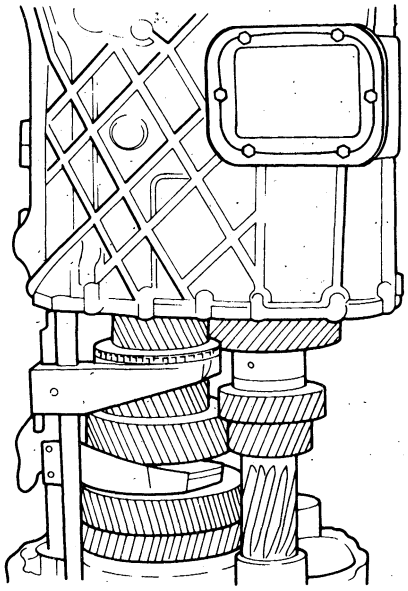
C8713-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

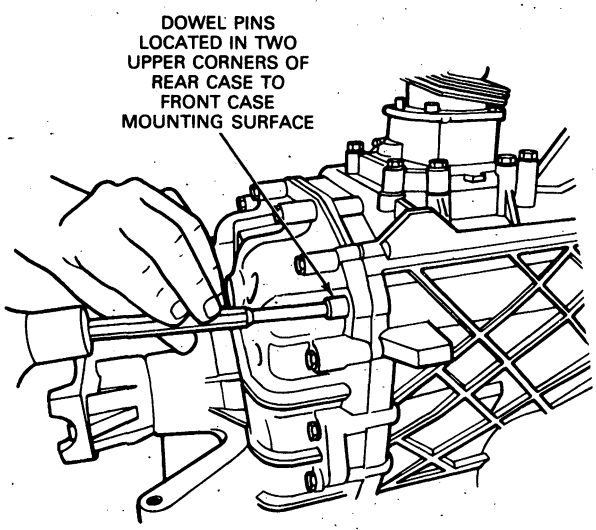
19. Carefully place the front case over the shafts and gearshift rails until it rests on its mating surface on the rear case. It may be necessary to push the central shift rail inward to clear the inner surfaces of the front case.

CAUTION: Be careful that the input shaft does not damage the front seal. Also be careful that the shim pack oil baffle is not bent when the case is positioned over the input shaft.



C9019-1A

20. Drive in the two dowels that align the rear case and the front case. Next, insert two hex screws and tighten them finger-tight.

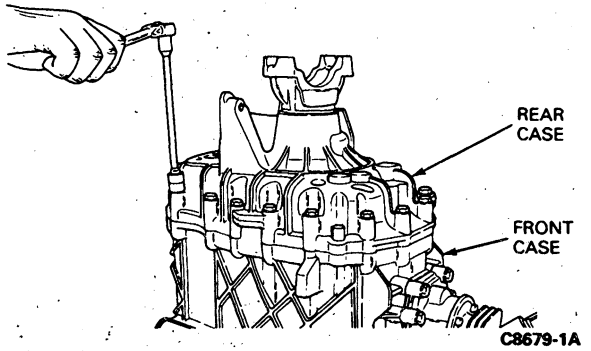


C9022-1A

21. Screw two additional hex screws into the rear case bores near the shafts finger tight.

NOTE: If it is not necessary to adjust the mainshaft/ input shaft preload. Install all of the hex screws that attach the two cases and tighten to 25 N·m (18 ft-lb).

CAUTION: Adjustment of tapered roller bearing preload is necessary if either the front or rear cases, countershaft, mainshaft or input shaft has been replaced, or if a tapered roller bearing on either shaft has been replaced. Refer to adjustments in this section for tapered roller bearing preload adjustment procedure before continuing assembly procedures.



C8679-1A

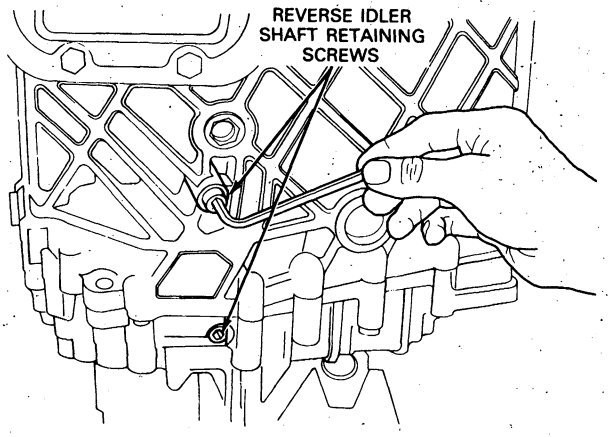
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DISASSEMBLY AND ASSEMBLY (Continued)

22. Fit sealing ring to the reverse idler shaft retaining capscrews. Install the screws into their bores in the front and rear cases and tighten to 22 N·m (16 ft-lbs). With a screwdriver push caps into the capscrews until they are flush with the surface of the screw head.

CAUTION: Use hand pressure for screwdriver only, do not hammer the caps into position.

23. Rotate the transmission so the input shaft is pointing down.

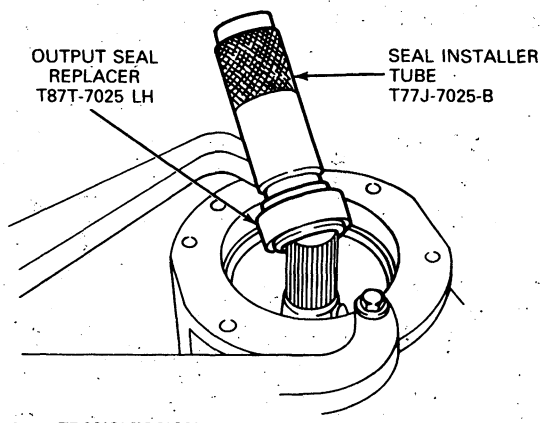


C8684-1A

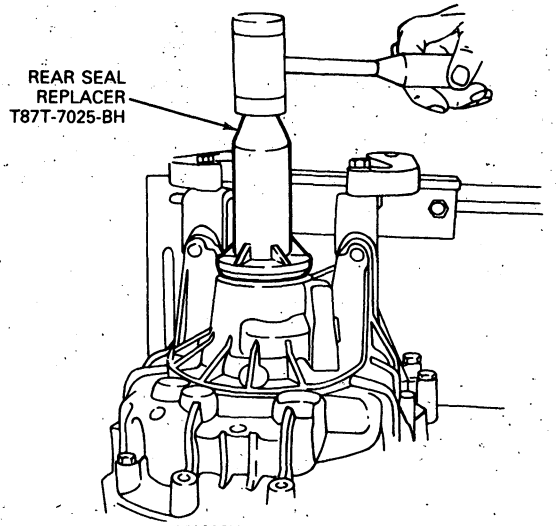
24. If equipped, install the speedometer drive gear on the mainshaft.

25. On 4x2 transmissions, remove the hex nut that secures the output flange to the mainshaft, then remove the flange from the shaft. Position the output shaft seal on Output Seal Replacer T87T-7025-BH or equivalent and position the seal and tool in the opening in the rear case. Using a soft hammer gently tap the seal in until it seats in the opening. Apply a little liquid soap around the circumference to minimize friction.

On 4x4 applications, Output Seal Replacer T87T-7025-LH or equivalent and Seal Installer Tube T77J-7025-B or equivalent to install the output shaft oil seal. Gently tap on tube with a soft hammer until tool seats against its stop.



4 x 4 TRANSMISSION REAR OIL SEAL INSTALLATION



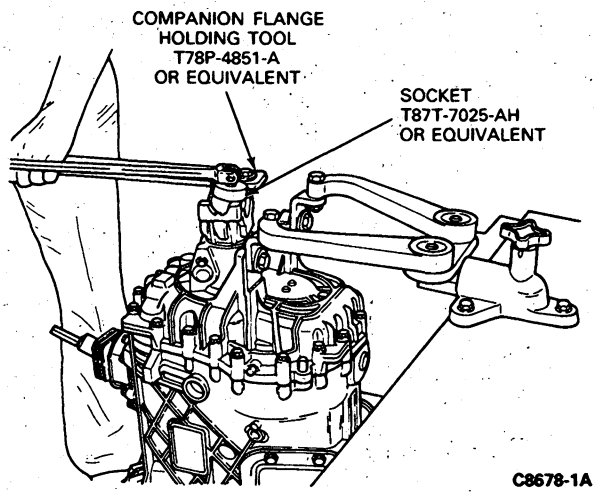
4 x 2 TRANSMISSION REAR OIL SEAL INSTALLATION

C8715-1A

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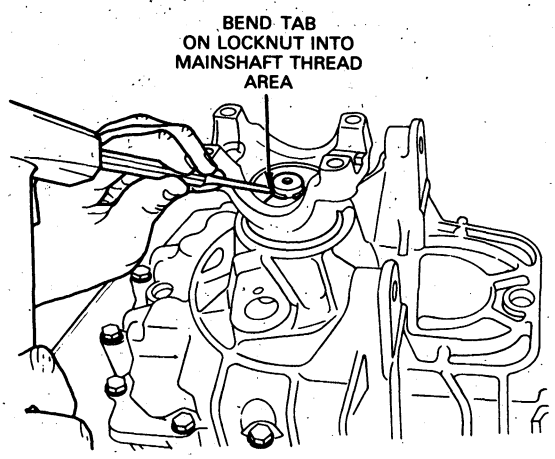
DISASSEMBLY AND ASSEMBLY (Continued)

26. On 4x2 applications, reinstall the output flange on the output shaft. Install Companion Flange Holder T78P-4851-A. Install the hex nut onto the mainshaft using locknut socket Tool T87T-7025-AH. Tighten the nut to 250 N·m (184 Ft-lbs).



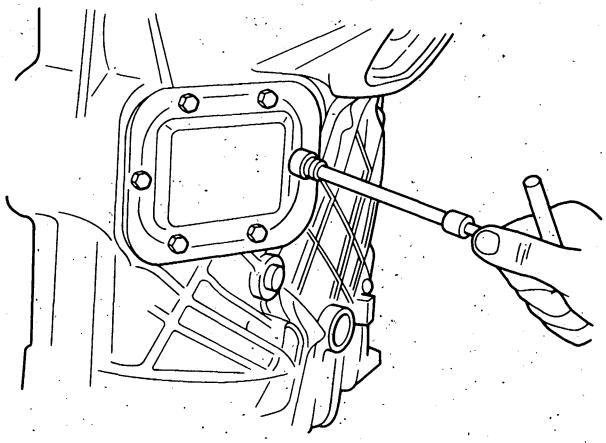
C8678-1A

27. Secure the locknut by bending a tab on the nut into the mainshaft.



C9023-1A

28. If required, install new gaskets and PTO covers over the openings in the front case using the original attaching screws which have self sealing threads and tighten to 38 N·m (28 ft-lbs.).


C8716-1A

29. Position the 5th-reverse gear interlock plate into its installed position as shown in the illustration. Place the gasket over the shift tower mating surface in the front case.

NOTE: Make sure that the stop plate moves freely and that the gasket does not interfere with it. The interlock plate must be in a position which is lower than the gasket so that the plate may move freely.

NOTE: Use care to ensure that the interlock plate or spring do not drop into the front case.

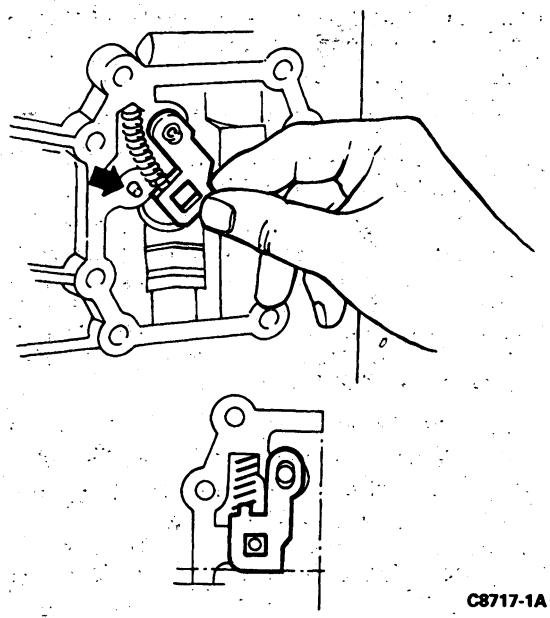
30. Check the interlock plate compression spring against Spring Specifications at the end of this Section to be sure that its unloaded length is satisfactory.

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DISASSEMBLY AND ASSEMBLY (Continued)

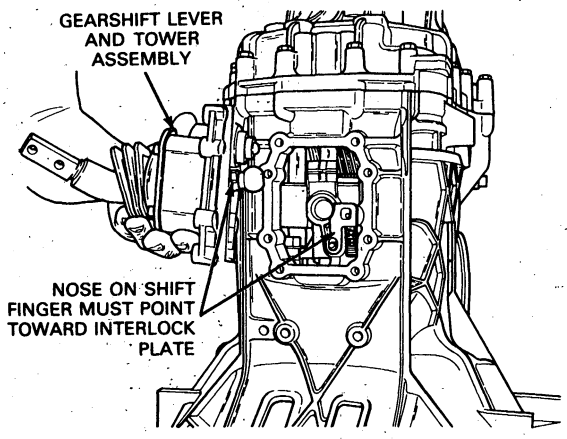
31. Place the spring above the nose in the interlock plate and move both parts into their installed positions.

CAUTION: The procedure must be followed exactly to ensure that the interlock function between fifth gear and reverse gear operates properly.



C8717-1A

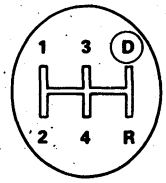
32. Install the shift tower assembly. The nose on the gearshift finger must point toward the interlock plate. Install spring washers and tighten screws to 25 N·m (18 ft-lbs).



C8718-1A

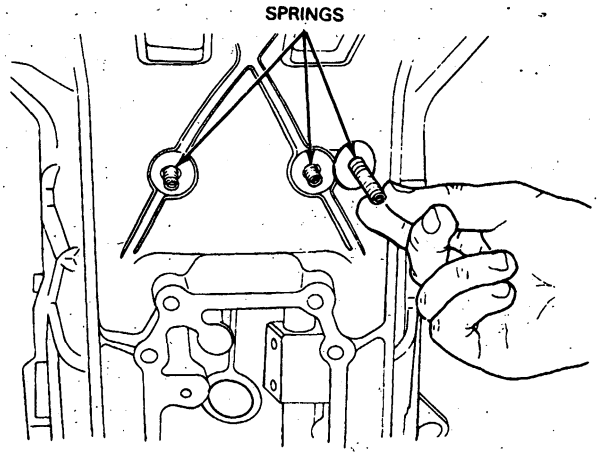
33. Check the functioning of the interlock. The shift lever cannot be shifted between fifth and reverse if the interlock was properly installed.

CAUTION: Do not force the lever to shift into reverse. Damage to the interlock components could occur.



C8719-1A

34. A compression spring is installed over each of the three detent bolts. The positions are shown in the illustration. Before installing the springs, check that their unloaded length is 44.1mm (1.736 in.).



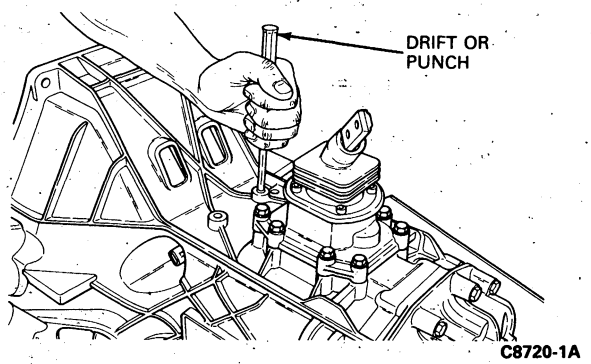
C8683-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

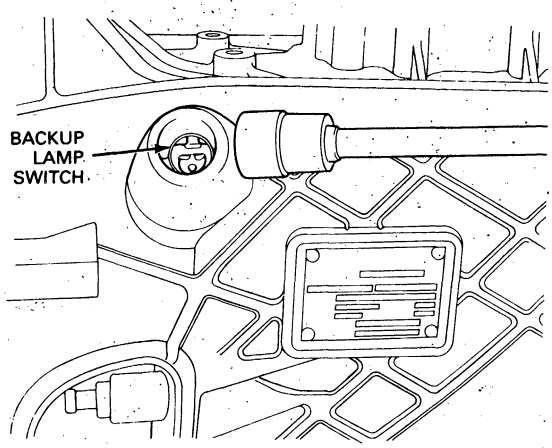
35. Install a new sealing cap in each bore in the front case where the detents, bolts and springs were installed. Use a suitable drift or punch to drive each cap in until it seats 1mm (3/64 in.) below the surface of the housing.

NOTE: Deeper installation will cause high shift efforts.



C8720-1A

36. If removed install the backup lamp switch with a new sealing ring into its mounting boss on the side of the front case near the transmission nameplate. Tighten the switch to 20 N·m (15 ft-lbs).



C8685-1A

ADJUSTMENTS

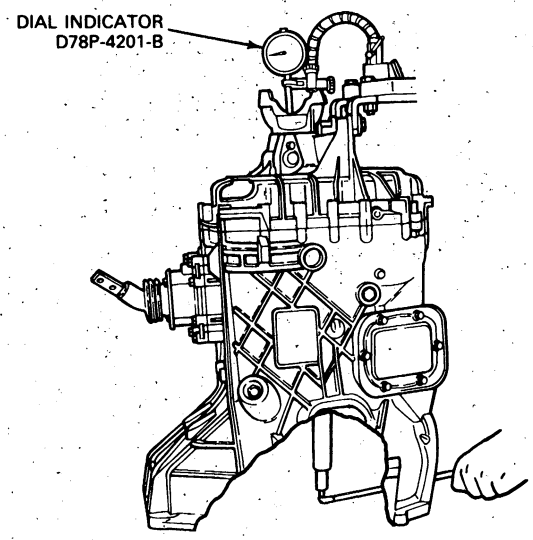
Bearing Preload Adjustment

Measurement and adjustment of the tapered roller bearings is necessary if a housing, countershaft, mainshaft or input shaft has been replaced or if a tapered roller bearing per shaft has been replaced. The mainshaft, input shaft, and countershaft should be adjusted to provide a preload of 0.00079 to 0.00434 inch (0.02-0.11 mm). After adjusting the two shafts, each should be rotated a few times to center the rollers in the bearings involved.

Input Shaft and Mainshaft Tapered Roller Bearing Preload Measurement

1. With the transmission placed on a bench with the output flange facing upward, attach a dial indicator gauge with a magnetic base, Tool D78P-4201-B (or equivalent) to the output flange in such a manner that the measurement bar will rest on the output end of the mainshaft as shown in the illustration.
2. Zero the dial indicator and, using a pry bar, gently pry up the input shaft and mainshaft.
3. Note the indicator gauge reading. A shim and baffle which is to be fitted later must have a combined thickness equal to the dimension recorded on the dial plus 0.00079 to 0.00434 inch (0.02 to 0.11mm). This will result in obtaining the specified preload after installation of the shims and shaft seal, and mainshaft and countershaft.

NOTE: Shims and baffle must be removed prior to preload measurement. The baffle is part of the shim package under the bearing race.



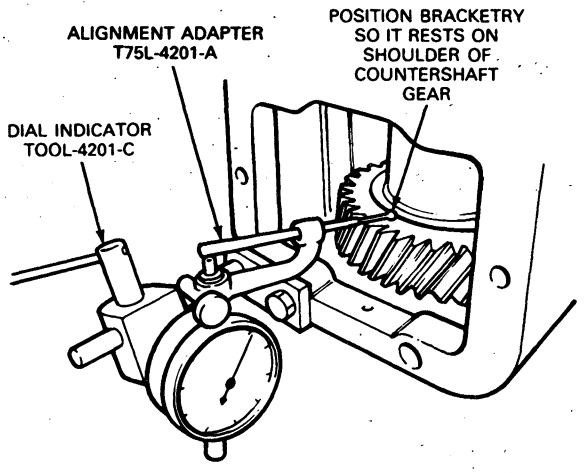
C8721-1B

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ADJUSTMENTS (Continued)

Countershaft Tapered Roller Bearing Preload Measurement

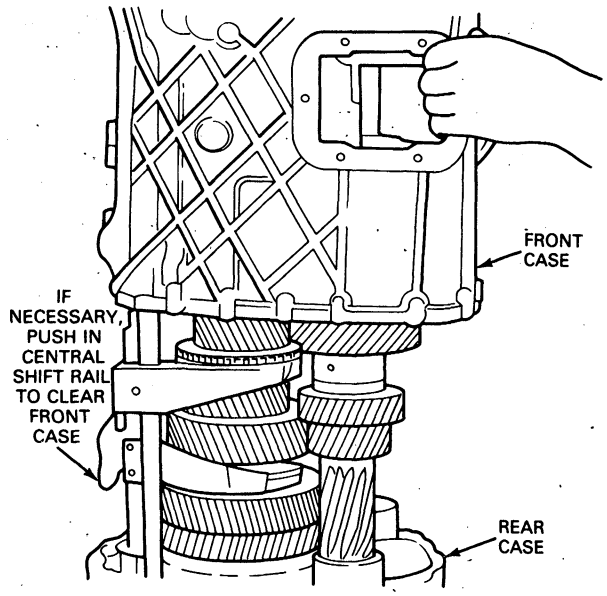
1. Using two 10mm hex screws, attach Dial Indicator with Bracketry TOOL-4201-C or equivalent, the P.T.O. opening in the front case as shown in the illustration. Position the dial indicator gauge to the support in such a way that the measurement bar rests against the flat face of the four speed helical gear on the countershaft.
2. Set the dial indicator needle to zero.
3. Insert pry bars through each of the two power take-off openings and position them beneath the 4th speed helical gear on the countershaft. Pry up on the countershaft.
4. Like the preceding shaft check, the preload should be 0.02 to 0.11mm (0.00079 to 0.00434 inch) after installing the shim.



C8722-1B

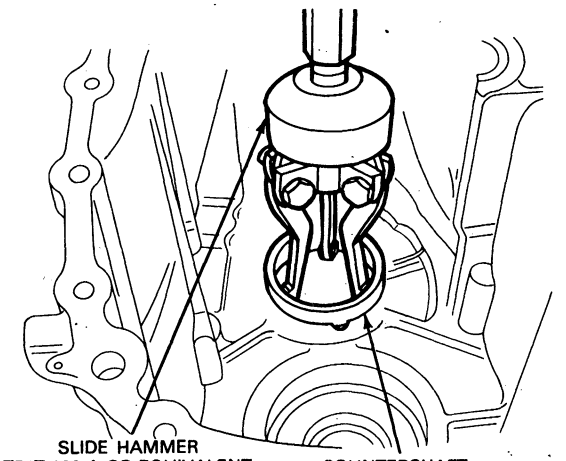
Mainshaft and Input Shaft Tapered Roller Bearing Preload Adjustment

1. After completing the tapered roller bearing preload measurements described previously, place the transmission in an upright position with the input shaft pointing upwards.
2. Drive the two dowel pins out of their holes in the front and rear cases and lift the front case off the rear case.



C8688-1A

3. Using Slide Hammer T50T-100-A or equivalent and Internal Puller D80L-943-A or equivalent, remove the countershaft and mainshaft tapered roller bearing outer races from the front case.



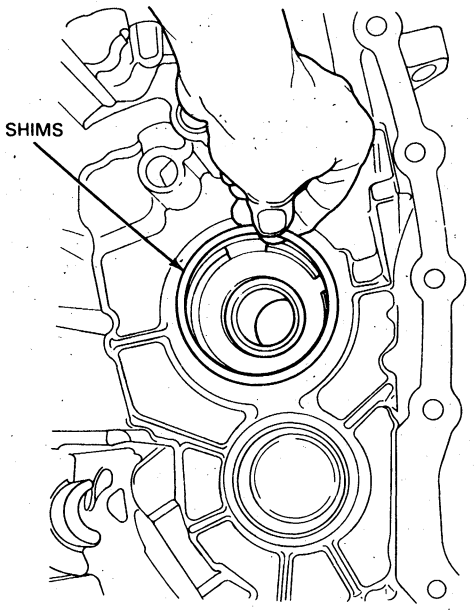
C8723-1A

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ADJUSTMENTS (Continued)

4. Fit each race with a shim washer or shim washer and baffle plate to obtain the required preload determined previously. Countershaft preload is established by using shims alone; input shaft and mainshaft preload is established by using shims and a baffle. In both cases the parts are installed beneath the outer race of the tapered roller bearing which seats in the front case.

NOTE: Always replace the baffle plate with a new one when removed.



C8724-1A

5. Apply Gasket Maker E2AZ-19562-B (ESE-M4G234-A2) or equivalent to the mating surfaces of the front and rear cases.

CAUTION: Do not use silicon.

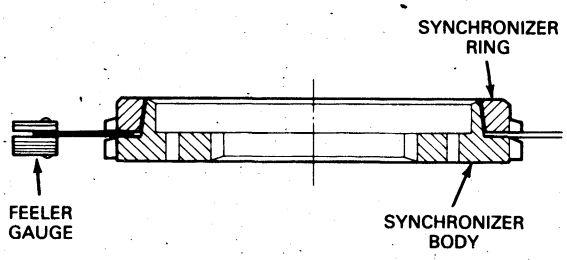
Position the front case on the rear case. Install all of the screws that secure the two front and rear cases and tighten to 22 N·m (16 ft- lbs.).

INSPECTION

For cleaning and inspection procedures other than that listed below, refer to Section 16-10, General Manual Transmission Service.

Synchronizer Ring/Synchronizer Body Wear Check

Position the synchronizer ring on the synchronizer body as shown in the illustration. Insert a feeler gauge and measure clearance at two opposite points. If clearance is less than 0.6mm (0.024 inch) for the 3rd-4th, 1st-2nd and 5th synchronizer assemblies and 0.4mm (0.016 inch) for the reverse synchronizer assemblies, replace the synchronizer ring, synchronizer body, or both if required to bring to within specification.



GEARS	CLEARANCE
1	0.6 mm (0.024 inch)
2	0.6 mm (0.024 inch)
3	0.6 mm (0.024 inch)
4	0.6 mm (0.024 inch)
5	0.6 mm (0.024 inch)
Reverse	0.4 mm (0.016 inch)

C8725-1B

Synchronizer Compression Spring Tension Check

Check the length and tension of all compression springs of synchronizers.

SPRING SPECIFICATIONS

Unloaded Length	O.D.	Wire Diameter
14.8 mm (0.583 in.)	5.960 mm (0.235 in.)	0.95 mm (0.037 in.)

CC8726-1A

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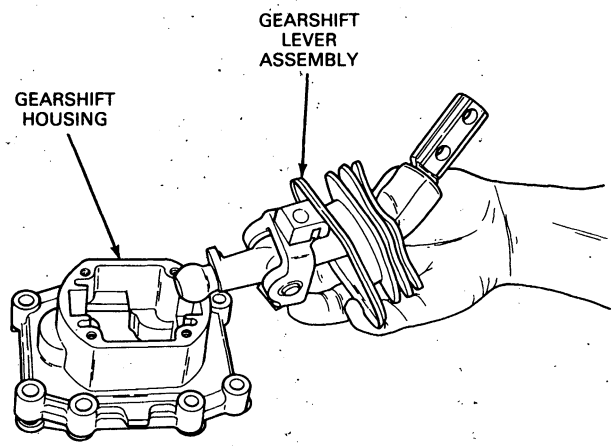
SUBASSEMBLIES

Shift Tower Assembly

Disassembly

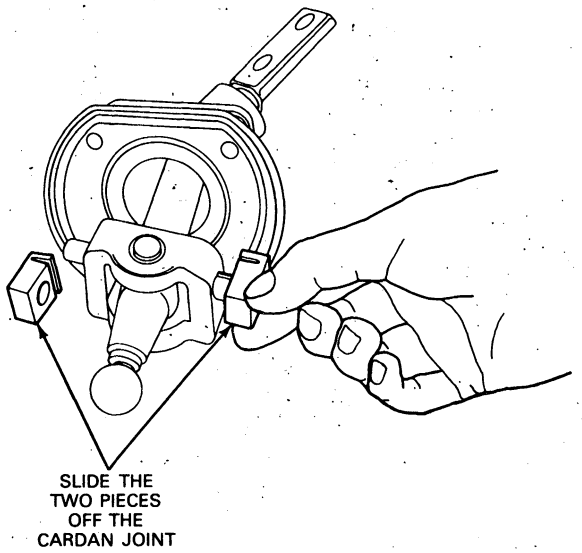
1. Remove the four capscrews that attach the gearshift lever cover to the gearshift housing. Lift the lever, boot, cover and attached parts off the housing as an assembly.

NOTE: Disassembly of parts inside the gearshift housing should be confined to replacement of the detent when necessary.



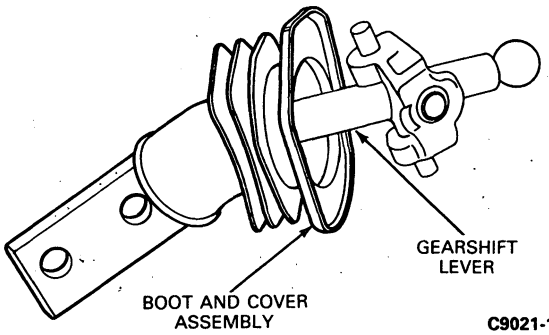
C8727-1A

2. Slide the two pieces off the cardan joint.



C8728-1A

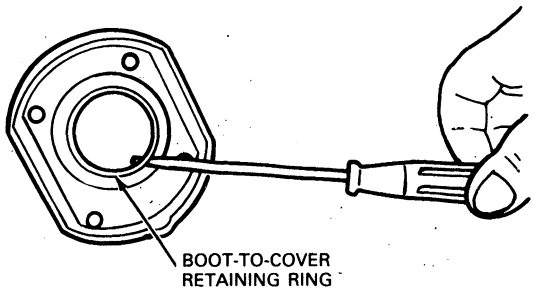
3. Slide the boot and cover as an assembly off past the top of the gearshift lever.



C9021-1A

4. Invert the cover with attached boot and remove the snap ring that secures the two parts.

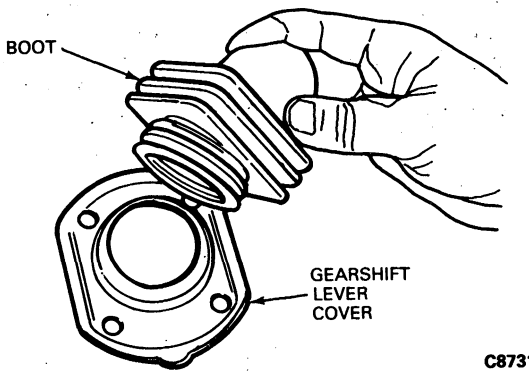
NOTE: A cross shaft passes through the cardan joint and gearshift lever and rides inside sleeved needle bearings that seat in the bores that seat in the joint. Do not disassemble these components.



C8730-1A

Assembly

1. Insert the boot in its upright position in the gearshift lever cover.

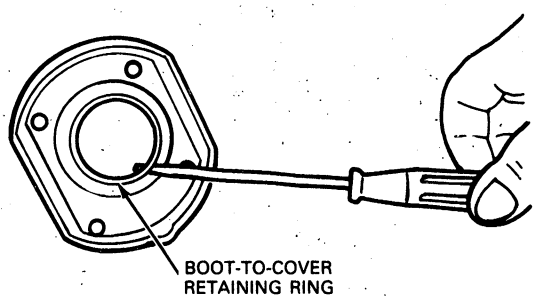


C8731-1A

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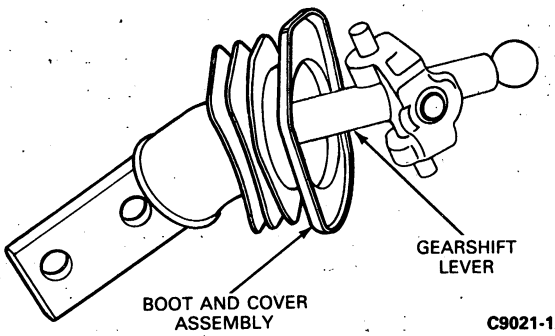
SUBASSEMBLIES (Continued)

2. Using a screwdriver, install the snap ring inside the boot so that the boot and ring will be secured in the groove in the cover.



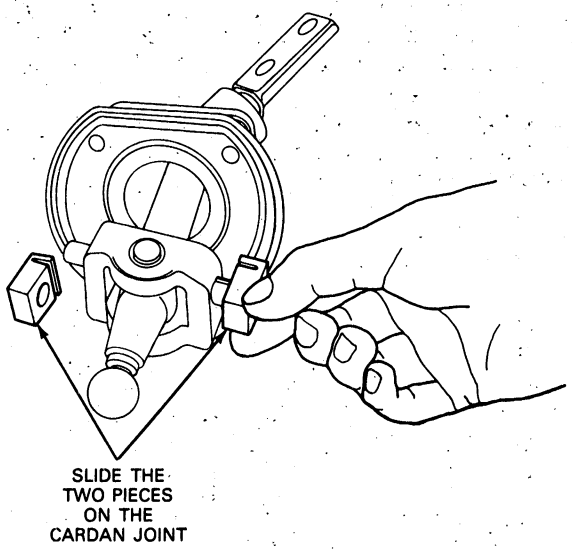
C8730-1A

3. Slide the boot and cover as an assembly on past the gearshift lever.



C9021-1A

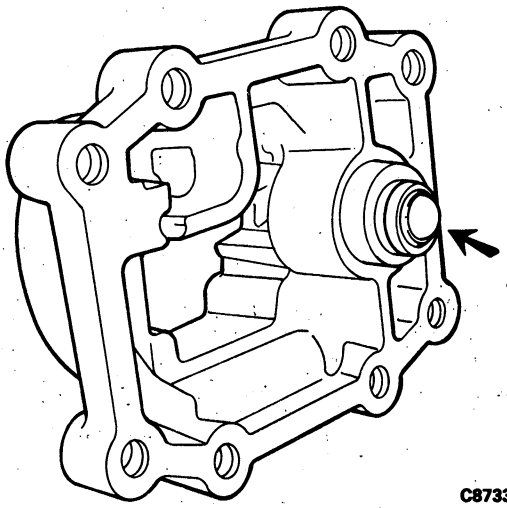
4. Place the two guide pieces on the lugs on the cardan joint. The slotted ends of the guide pieces should be located near the cover pointing inwards toward the shift lever.



C8732-1A

5. If required, install a new detent in the gearshift housing. Using Rotunda Heat Gun 107-00300,

Heat the detent mounting area in the housing to approximately 248°F (120°C). Press the detent into its mounting hole until it rests against its stop in the base of the hole.



C8733-1A

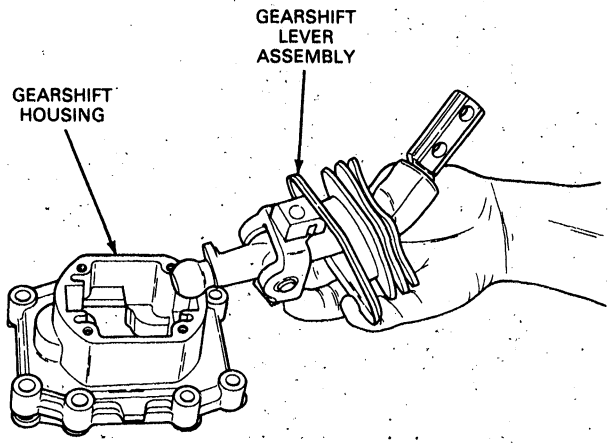
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SUBASSEMBLIES (Continued)

6. Place a new gasket on the upper surface of the gearshift housing. Place the gearshift lever with the attached guide pieces into the guide piece grooves. The slotted ends of these guide pieces must face upward.

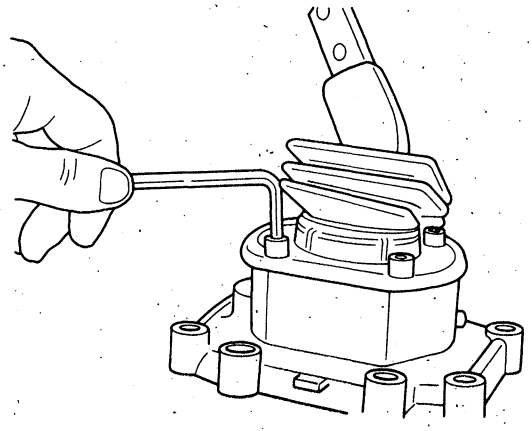
CAUTION: Do not use silicon sealant.

NOTE: The nose on the gearshift lever located just above the ball must face toward the location into which the stop plate and compression spring will be subsequently installed.



C8727-1A

7. Tighten the four capscrews that secure the head assembly to the gearshift housing to approximately 10 N·m (7 ft-lbs).

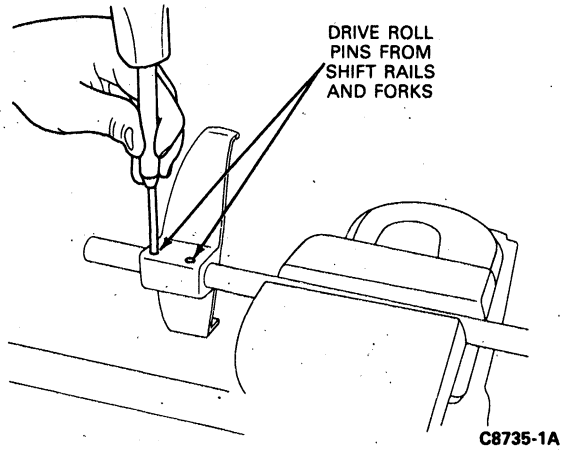


C8734-1A

Shift Rails

Disassembly

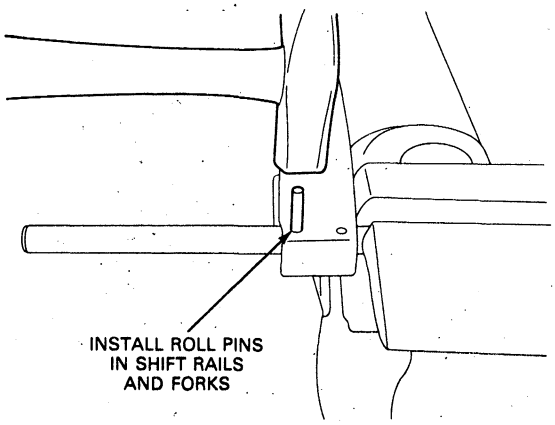
1. Install each rail in a vise with soft jaws or equivalent and, using a suitable drift punch or equivalent, drive two roll pins out of the 1st-2nd and 5th-Reverse shift fork and the gearshift finger on the central shift rail. Slide each of the forks off its rail and the finger off the central shift rail.



C8735-1A

Assembly

1. Position each shift rail in a vise equipped with soft jaws or equivalent to prevent damage.
2. Slide the fork onto the rail from which it was removed.
3. Drive the roll pins through the fork or finger and through the rail.



C8736-1A

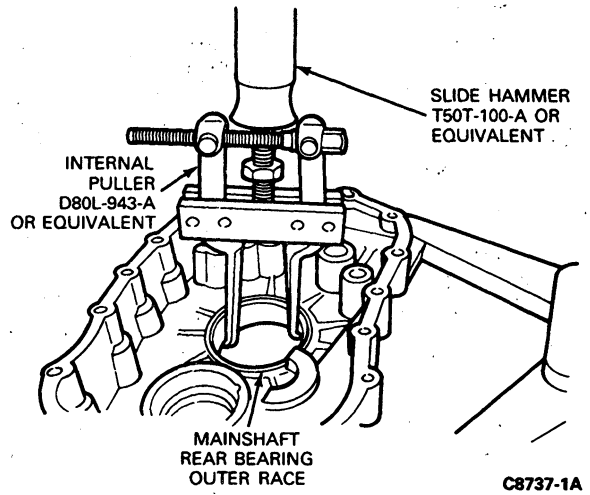
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SUBASSEMBLIES (Continued)

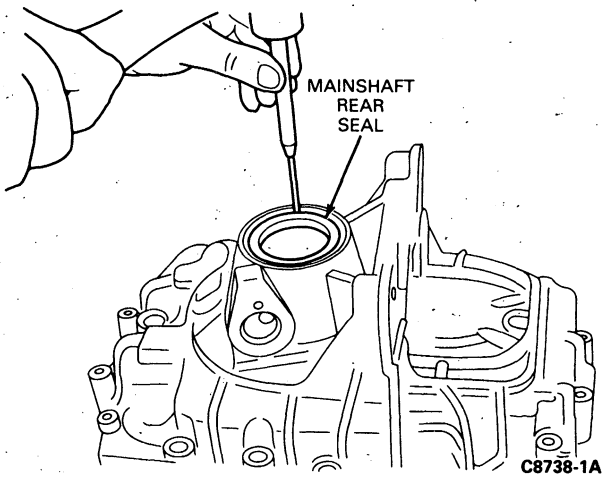
Transmission Rear Case

Disassembly

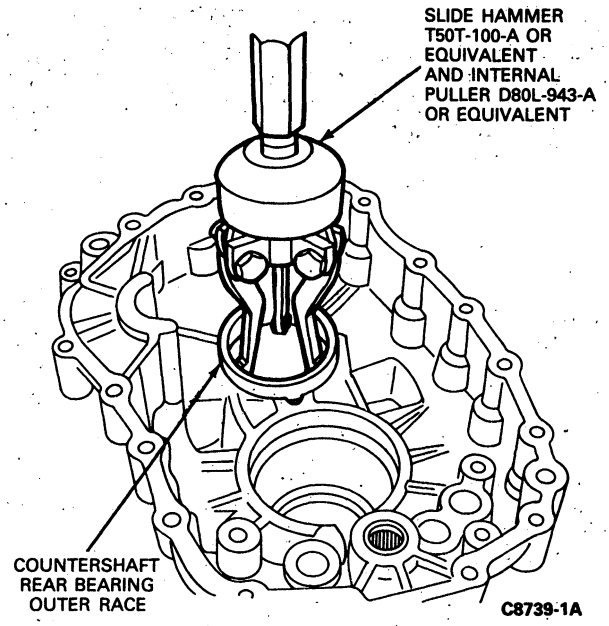
1. If required, drive the two dowel pins out of the rear case.
2. Using Slide Hammer T50T-100-A or equivalent and Internal Puller D80L-943-A or equivalent, remove the mainshaft rear bearing outer race from the rear case.



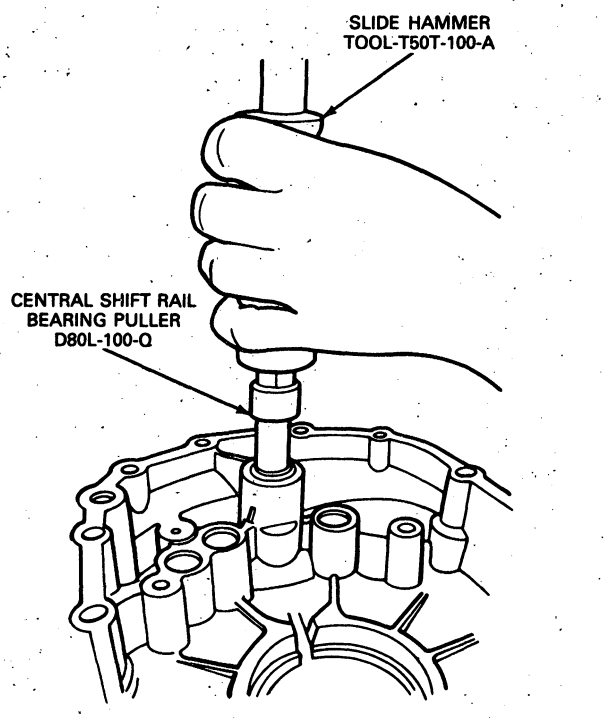
3. Using a suitable drift, drive the mainshaft rear seal out of the rear case. Discard the seal.



4. Using slide hammer T50T-100-A or equivalent and Bearing Cup Puller T77F-1102-A or equivalent, remove the countershaft rear bearing outer race from the rear case.



5. If required, remove the central shift rail bearing from the rear case. Use Blind Hole Puller D80L-100-Q and Slide Hammer T50T-100-A to remove the bearing.

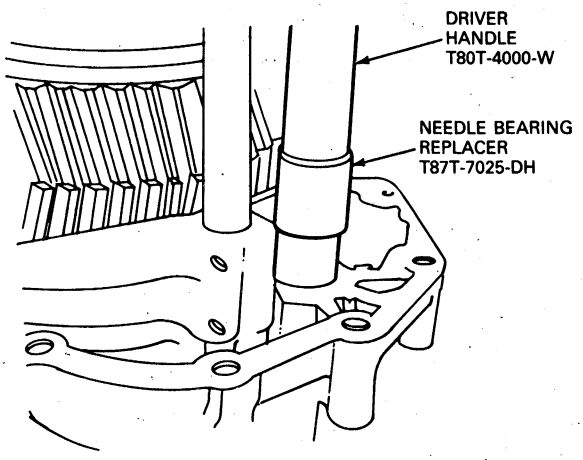


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SUBASSEMBLIES (Continued)

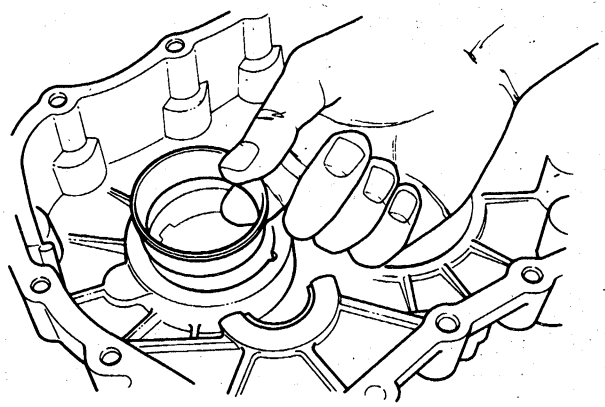
Assembly

1. If removed, install the central shift rail bearing into the rear case. Heat the rear case in the area of the bearing bore to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Insert the ball sleeve and drive the bearing in until it seats against its stop using Needle Bearing Replacer T87T-7025-DH.



C8741-1A

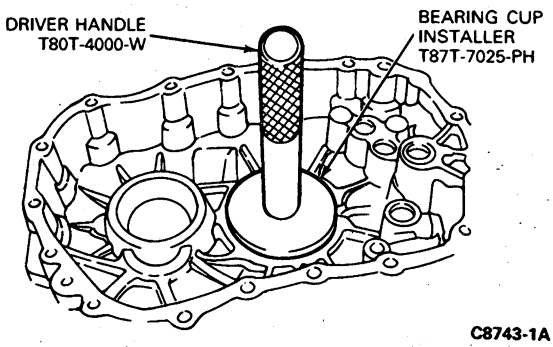
2. Heat the rear case in the area of the countershaft rear bearing outer race to 160°C (320°F) with Rotunda Heat Gun 107- 00300 or equivalent. Install the countershaft bearing outer race with Driver Handle T80T-4000-W and Bearing Cup Replacer T73T-4222-A until it seats against its stop.



C8742-1A

3. Heat the rear case in the area of the mainshaft outer race to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Using Driver Handle T80T-4000-W and Bearing Cup replacer T87T-7025-PH, tap the bearing cup into its bore until it seats against its stop.

NOTE: Do not install the mainshaft rear seal at this time. The mainshaft rear seal is installed just prior to installing the output flange.



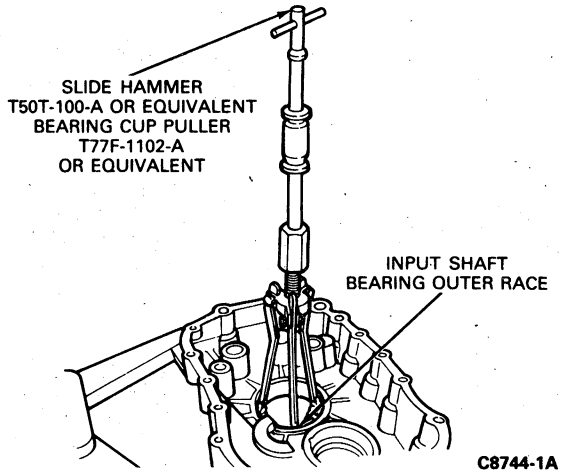
C8743-1A

Transmission Front Case

Disassembly

1. Using Slide Hammer T50T-100-A or equivalent and Bearing Cup Puller T77F-1102-A or equivalent, remove the input shaft bearing outer race from the front case.
2. Remove the baffle and shims.

NOTE: The oil baffle will be destroyed when the race is removed. Discard the oil baffle and install a new one during assembly.



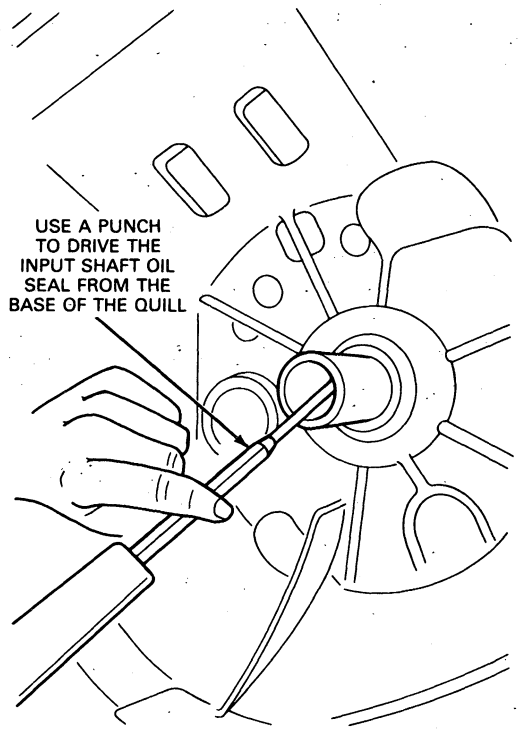
C8744-1A

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SUBASSEMBLIES (Continued)

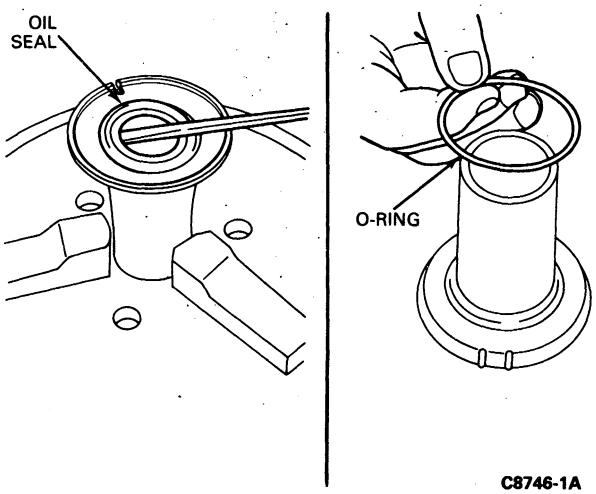
3. Using a punch, remove the input shaft oil seal from the base of the quill.

NOTE: If the quill is being removed, the input shaft seal may be removed later when the quill is out of the housing.



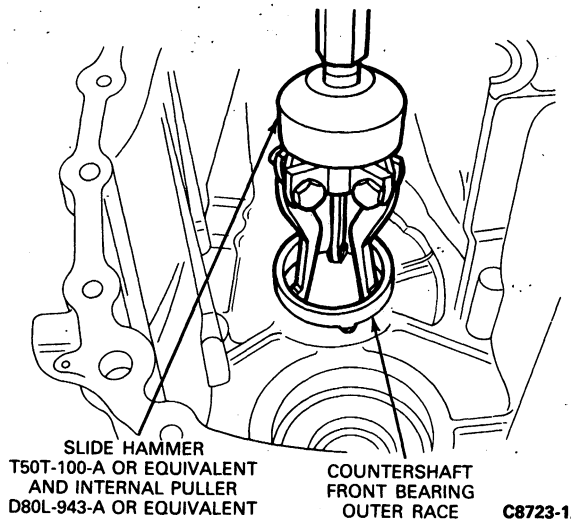
C8745-1A

4. If required, carefully tap the quill from the front case using a soft mallet.
5. Remove the O-ring from the quill. Remove the oil seal if not already removed.



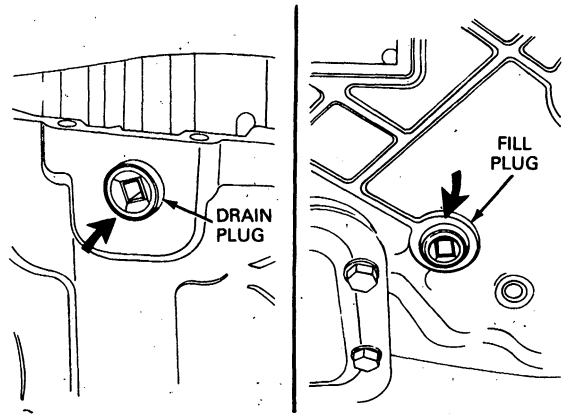
C8746-1A

6. Remove the countershaft front bearing outer race with Slide Hammer T50T-100-A and Internal Puller T77F-1102-A.



C8723-1A

7. If required, remove the fluid drain and fill plugs from the front case.

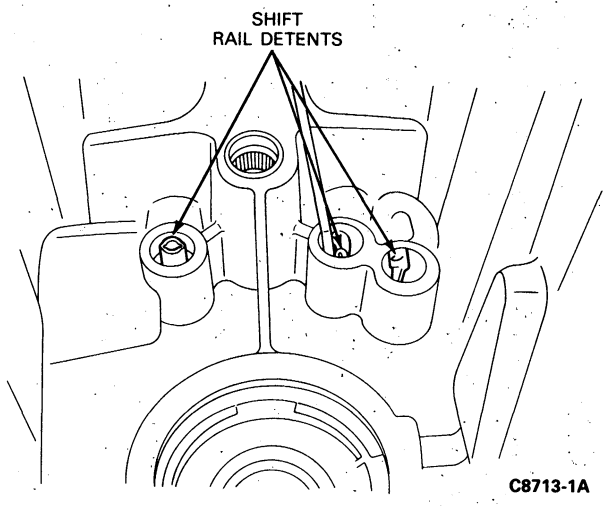


C8747-1A

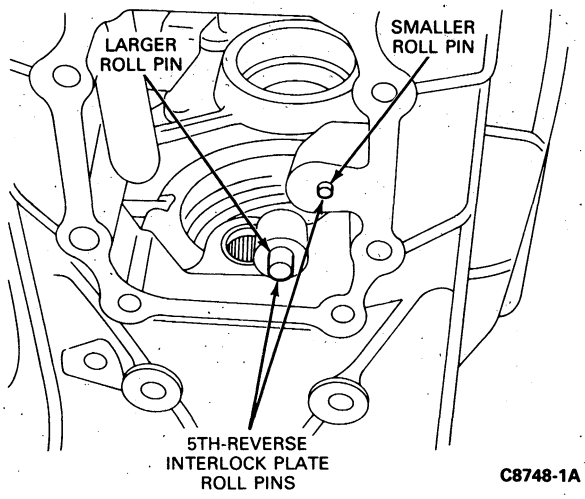
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SUBASSEMBLIES (Continued)

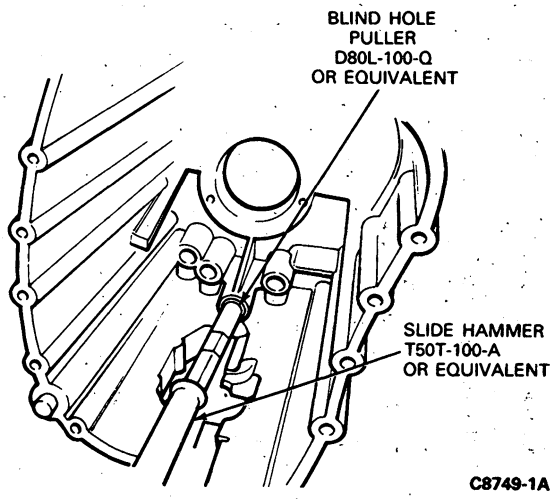
8. If required, remove the sealing caps and three shift rail detents from the front case.



9. If required, remove the roll pins that hold the 5th-reverse interlock plate from their bores in the front case just below the gearshift housing.

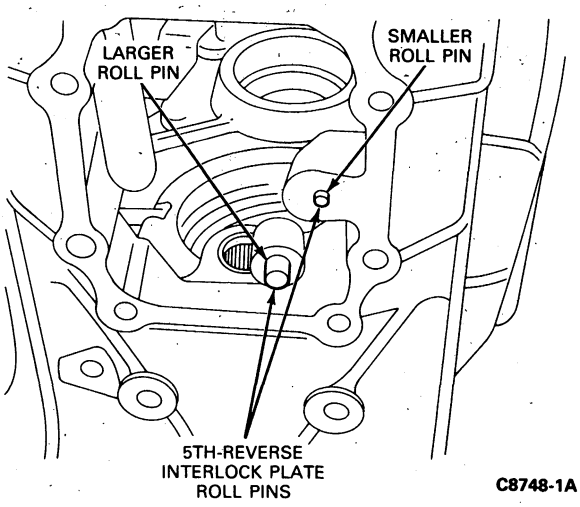


10. If required, remove the central shift rail needle bearing from the front case using Slide Hammer T50T-100-A or equivalent and Blind Hole Puller D80L-100-Q or equivalent.



Assembly

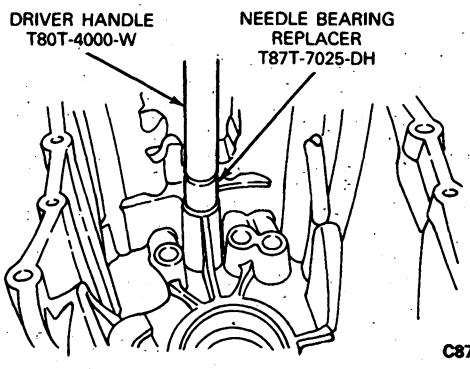
1. If they were removed, tap the 5th-reverse roll pins into their bores in the front case until the bigger one bottoms out (sticks out approximately 8mm (.315 inch); the small one sticks out 4- 5mm (.158-.197 inch). Do not allow it to bottom out.



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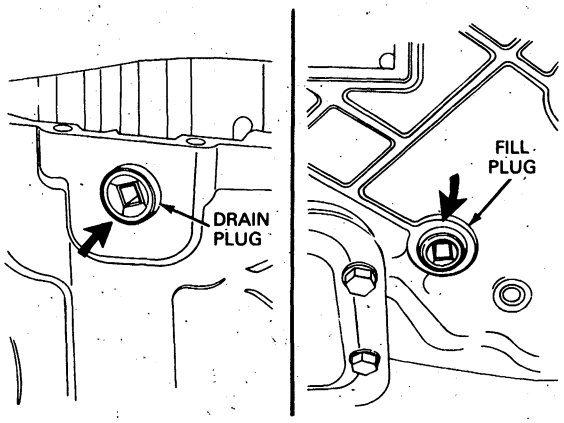
SUBASSEMBLIES (Continued)

2. Heat the front case in the area of the central shift rail bearing bore to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Drive the bearing sleeve in with needle bearing replacer T87T-7025-DH and Driver Handle T80T-4000-W or equivalent until it is flush with the surface of the bore.



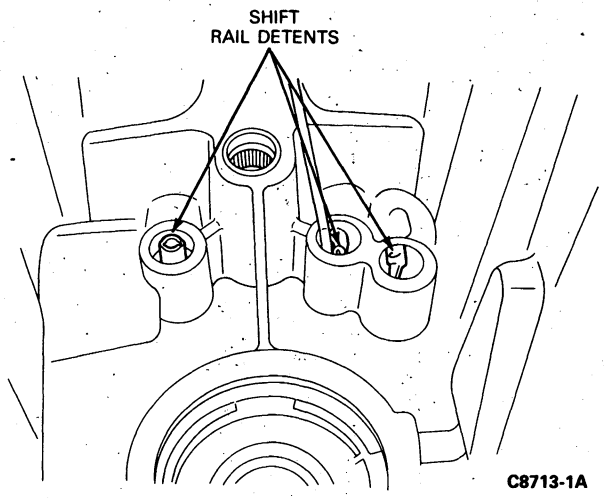
C8750-1A

3. If removed, install the drain and fill plugs into the front case. Tighten to 40 N·m (29 ft-lbs) (These torque values apply to a cold housing).



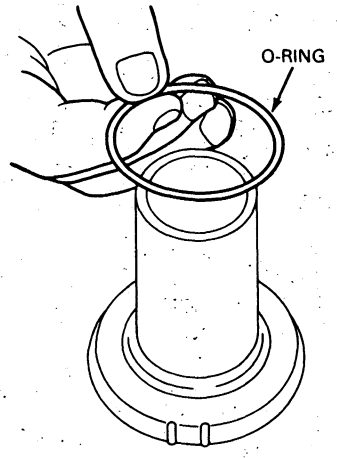
C8747-1A

4. Insert the three shift rail detent bolts into their respective bores in the front case. They must seat in the detents in their respective shift rails and must move freely when in their installed positions.



C8713-1A

5. Place a new O-ring on the input shaft quill.

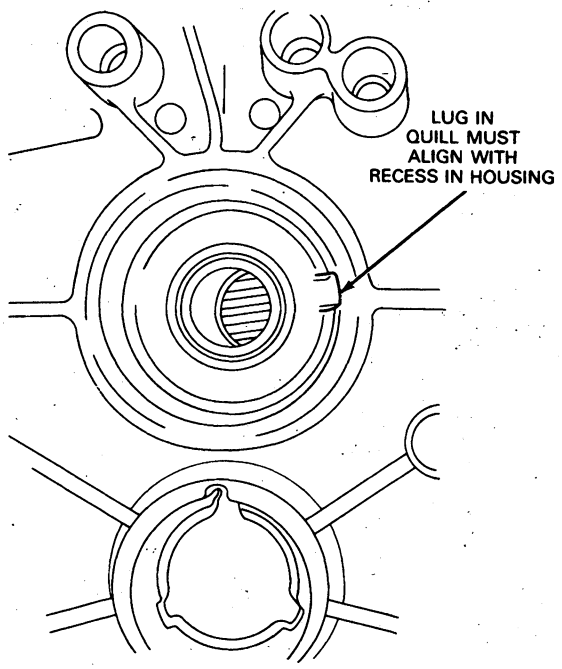


C8751-1A

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SUBASSEMBLIES (Continued)

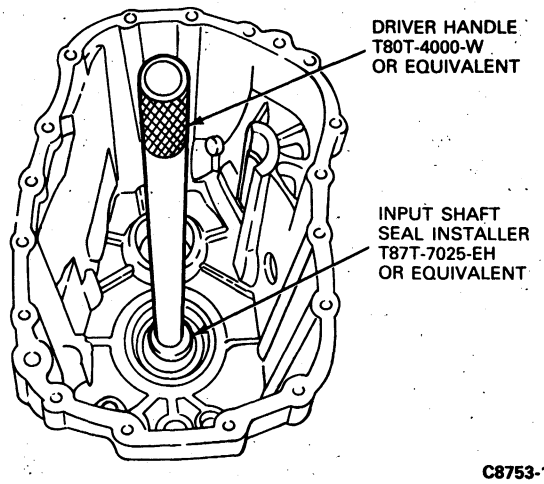
6. Position the quill in the housing in such a way that the lug in the quill is in alignment with the recess in the housing. Push the quill in until it bottoms against its bore in the housing.



C8752-1A

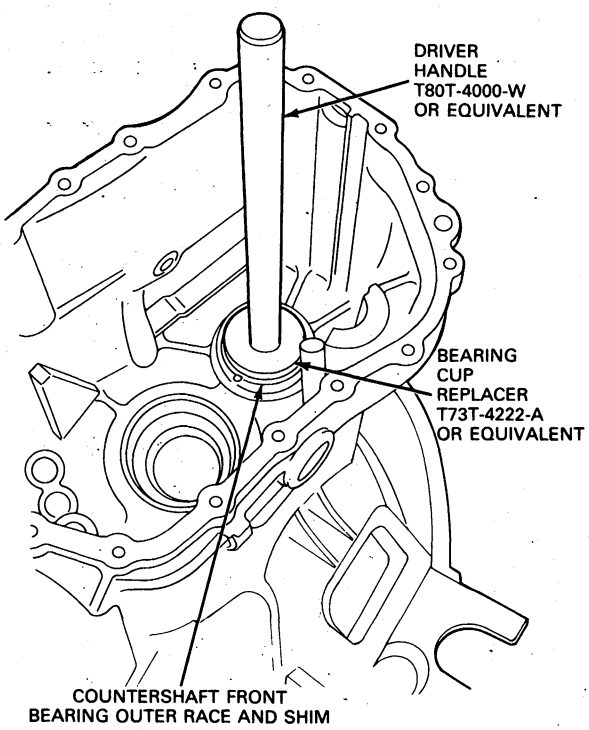
7. Position the seal in the front case. Using Driver Handle T80T-4000-W or equivalent and Input Shaft Seal Installer T87T-7025-EH or equivalent, drive in the seal until it seats against its stop in the quill.

CAUTION: If the countershaft, input shaft, mainshaft or one or more tapered roller bearing has been replaced, it is mandatory that the tapered roller bearings be adjusted to obtain a preload of 0.02 to 0.11mm (0.00079 to 0.00343 inch). Refer to adjustments in this section for procedure.



C8753-1A

8. Heat up the mounting bore in the front case for the taper roller bearing outer race of the countershaft to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent.
9. Position the shim with proper thickness in the bore. Using Driver Handle T80T-4000-W or equivalent and Bearing Cup Replacer T73T-4222-A or equivalent, drive the countershaft bearing outer race in until it seats against the stop in the case.

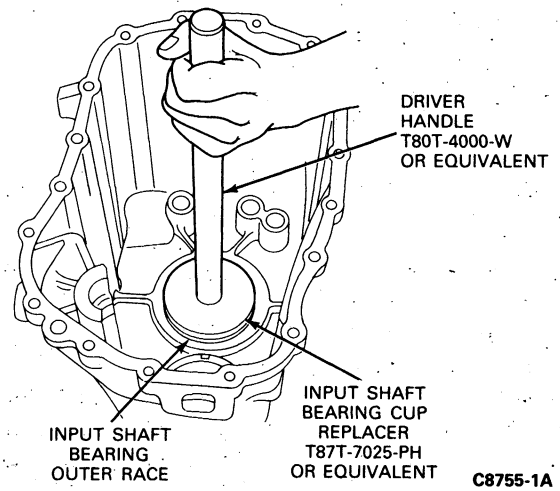


C8754-1A

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SUBASSEMBLIES (Continued)

10. Heat the front case in the area of the input shaft tapered roller bearing outer race to 160°C (320°F) with Rotunda Heat Gun 107- 00300 or equivalent.
11. Position the correct shim/sealing disc pack in the bore for the input shaft bearing outer race. Using driver handle T80T-4000-W or equivalent and Mainshaft Bearing Cup Replacer T87T-7025-PH or equivalent, drive the bearing cup in until it seats its stop in the bore.



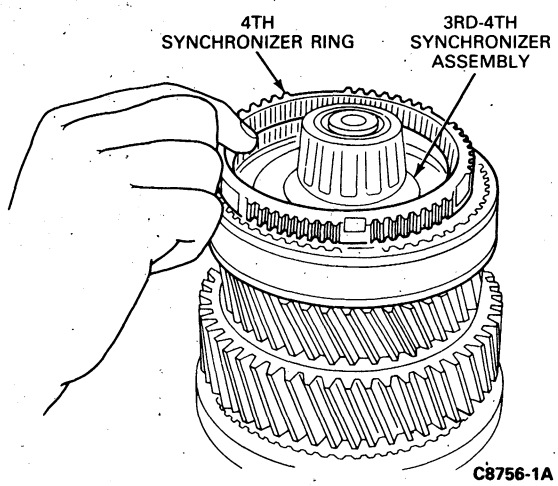
Mainshaft

Disassembly

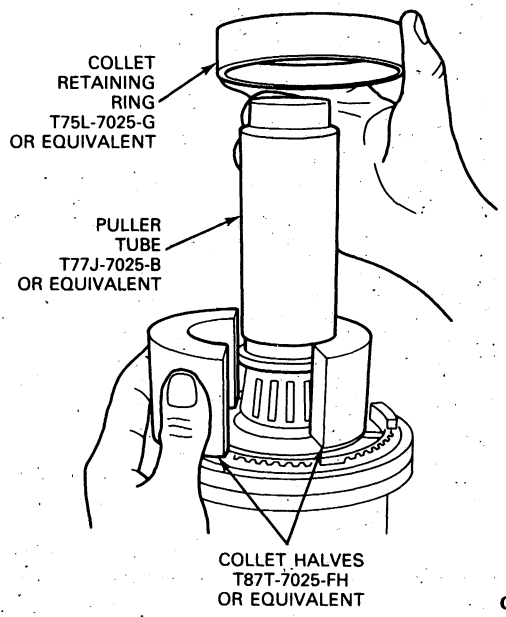
1. Clamp the output end of the main shaft firmly in a vise.

NOTE: Use brass pads or equivalent to prevent damage.

2. Remove the 4th synchronizer ring from the 3rd-4th synchronizer assembly.

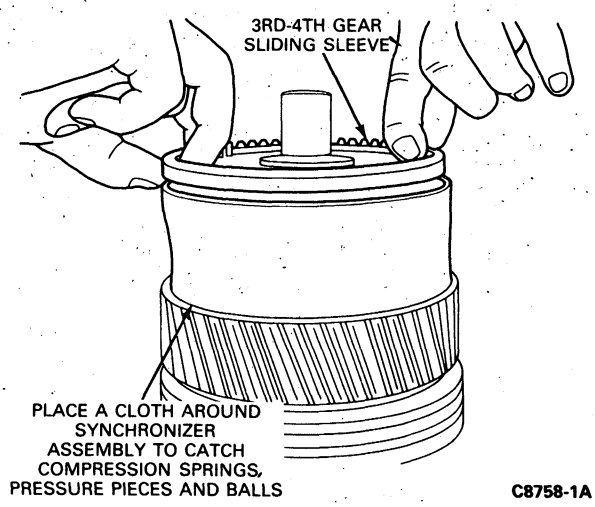


3. Place the Bearing Collets T87T-7025-FH or equivalent on either side of the mainshaft front bearing. Position the Puller Tube T77J-7025-B or equivalent in the collets. Pass the Collet Retaining Ring, T75L-7025-G or equivalent over the Puller and into the collets so they clamp firmly to the bearing. Pull the bearing from the mainshaft.



4. Remove the 3rd-4th gear sliding sleeve from the mainshaft.

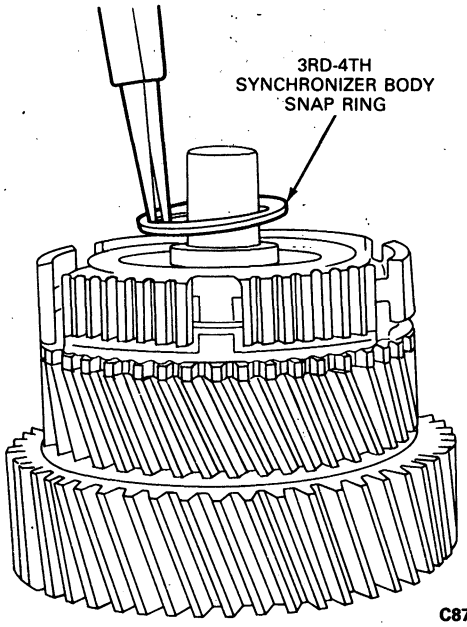
CAUTION: Place a cloth around the synchronizer assembly to catch the compression springs, pressure pieces and balls that will be released when the sliding sleeves are removed.



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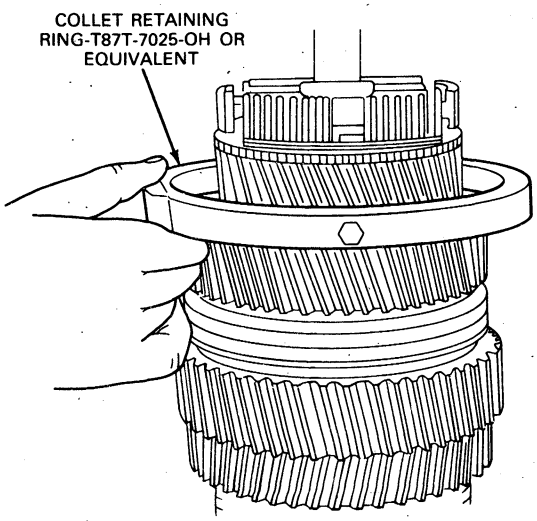
SUBASSEMBLIES (Continued)

5. Remove the snap ring that retains the 3rd-4th synchronizer body to the mainshaft.



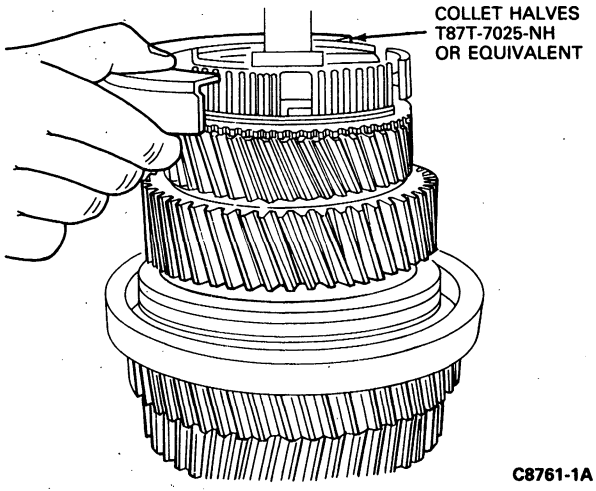
C8759-1A

6. Place the Collet Retaining Ring T87T-7025-OH or equivalent over the mainshaft and let it rest on the mainshaft 1st gear.



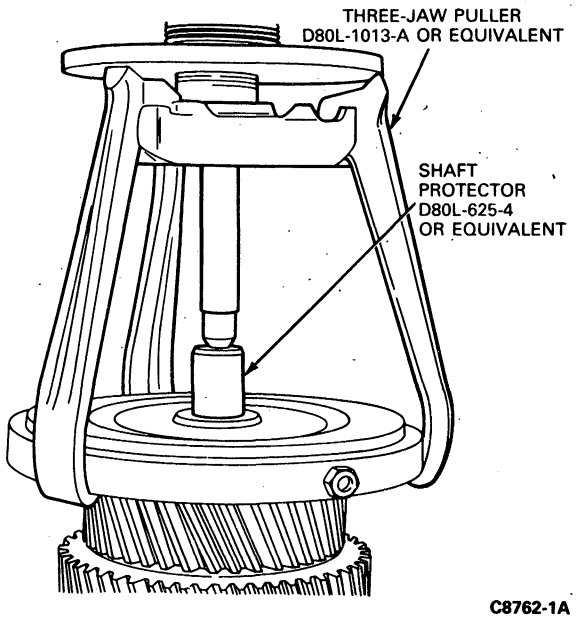
C8760-1A

7. Position the two collet halves T87T-7025-NH or equivalent on the 3rd-4th synchronizer body and slide the collet retaining ring over the collet halves to hold them in place on the synchronizer body.



C8761-1A

8. Place the Shaft Protector D80L-625-4 or equivalent on the end of the mainshaft. Place the Three Jaw Puller D80L-1013-A or equivalent on the assembled collet halves and retaining ring and pull the synchronizer body from the main shaft.

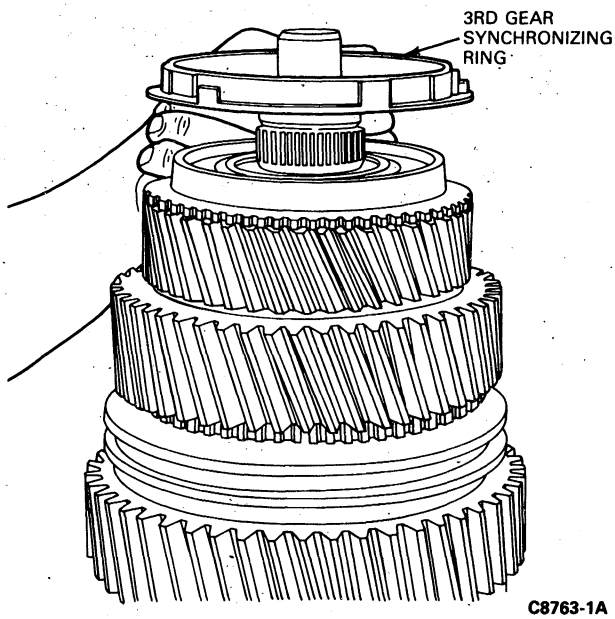


C8762-1A

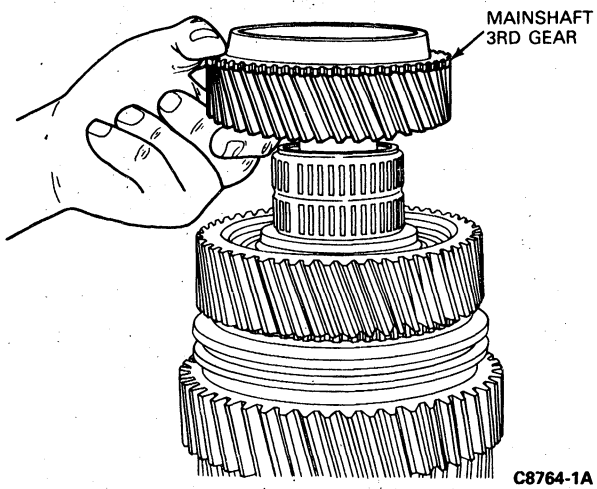
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SUBASSEMBLIES (Continued)

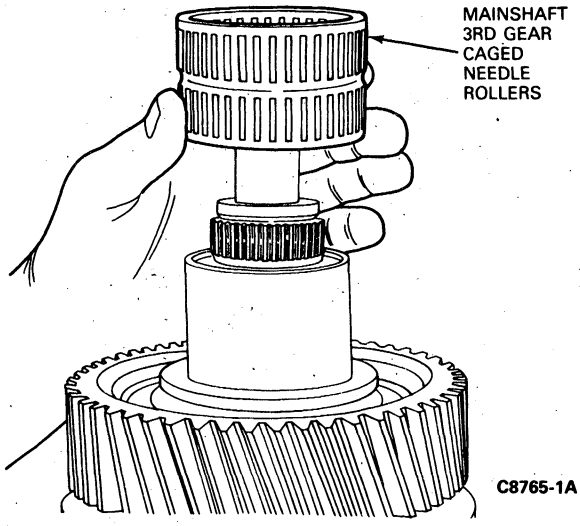
9. Remove the synchronizer ring from the mainshaft 3rd gear.



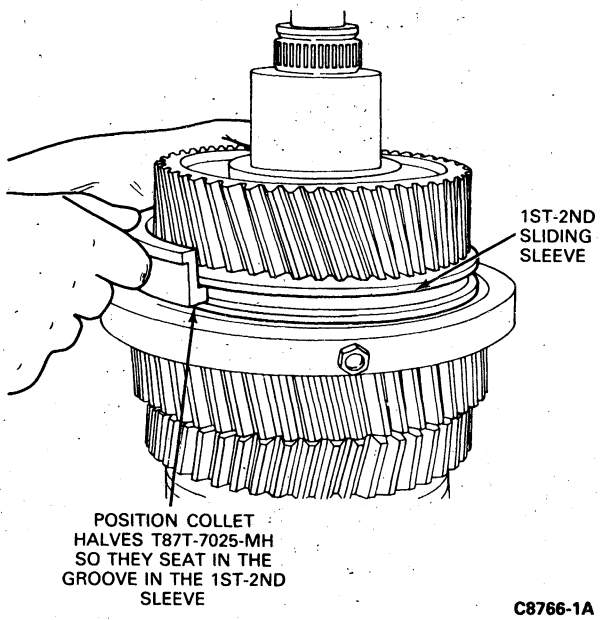
10. Remove the 3rd gear from the mainshaft.



11. Remove the 3rd gear caged needle rollers from the mainshaft.



12. Lift the 1st-2nd gear sliding sleeve up as far as it will slide.
13. Position the Collet Retaining Ring T87T-7025-OH or equivalent over the main shaft and let it rest on the 1st gear.
14. Position the two collet halves, T87T-7025-MH or equivalent so they seat in the groove in the 1st-2nd sliding sleeve. Pass the retaining ring from below over the two halves and secure them to the sliding sleeve.

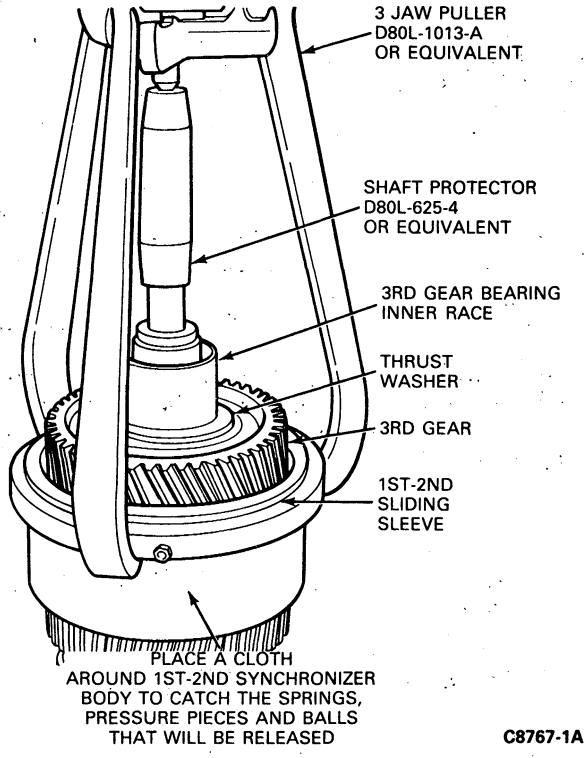


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SUBASSEMBLIES (Continued)

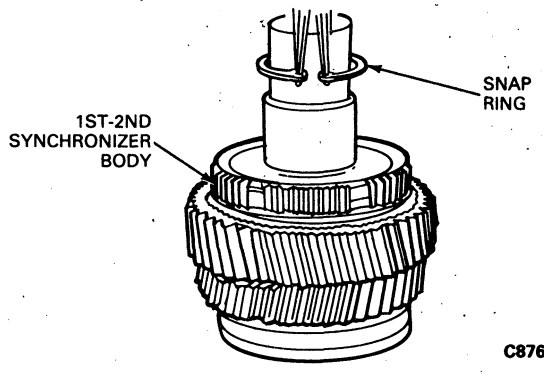
15. Position Shaft Protector D80L-625-4 or equivalent on the end of the mainshaft. Position the Three-Jaw Puller D80L-1013-A or equivalent on the collet retaining ring and pull the 1st- 2nd sliding sleeve, 2nd gear, thrust washer, and 3rd gear bearing inner race from the mainshaft.

CAUTION: Position a cloth around the 1st-2nd synchronizer body to catch the springs, pressure pieces and balls that will be released when the sliding sleeve clears the 1st-2nd synchronizer body.



C8767-1A

16. Remove the snap ring retaining the 1st-2nd synchronizer body to the mainshaft.



C8768-1A

17. Reposition the mainshaft in the vise so that the output end of the shaft is now facing up.

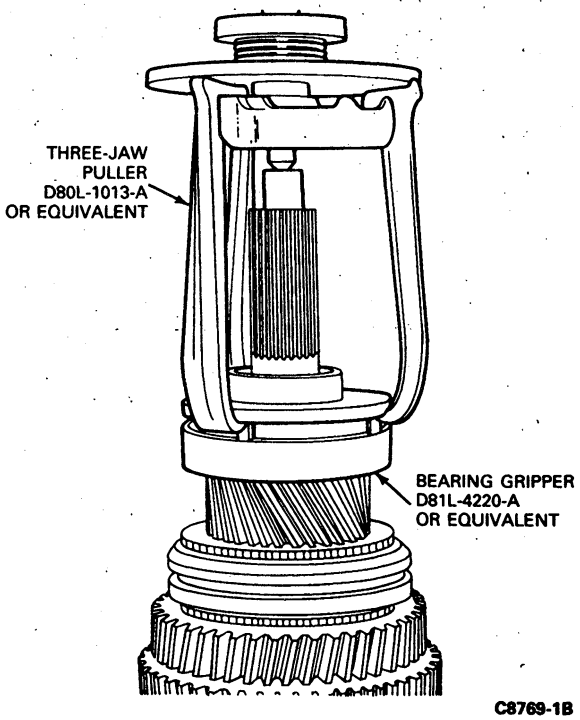
NOTE: Use brass pads or equivalent to prevent damage.

NOTE: On 4x4 versions and F-Super Duty versions, a snap ring retaining the taper roller bearing inner race should be removed.

18. Position a bearing gripper such as D81L-4220-A on the mainshaft rear tapered roller bearing. The gripper used must pull the bearing assembly by the shoulder of the tapered rollers, not from the bearing cage.

CAUTION: Failure to use a bearing gripper will destroy the bearing.

19. Position Three-Jaw Puller D80L-1013-A or equivalent on the bearing gripper and pull the mainshaft rear tapered roller bearing from the mainshaft.

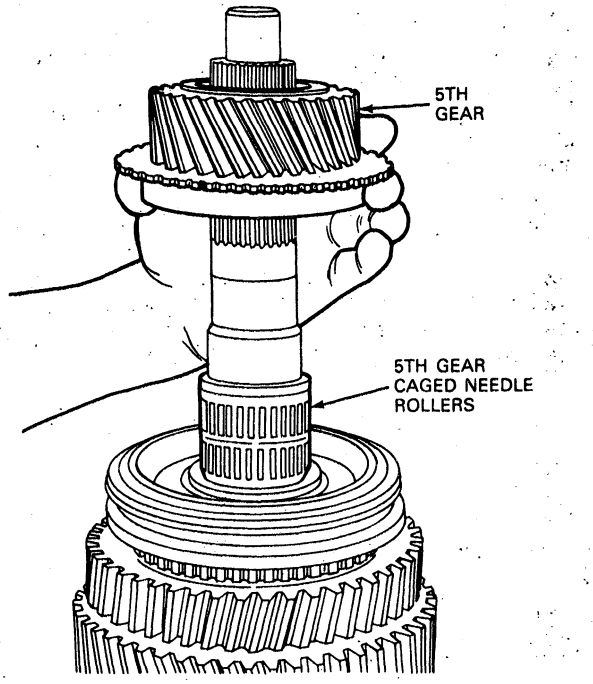


C8769-1B

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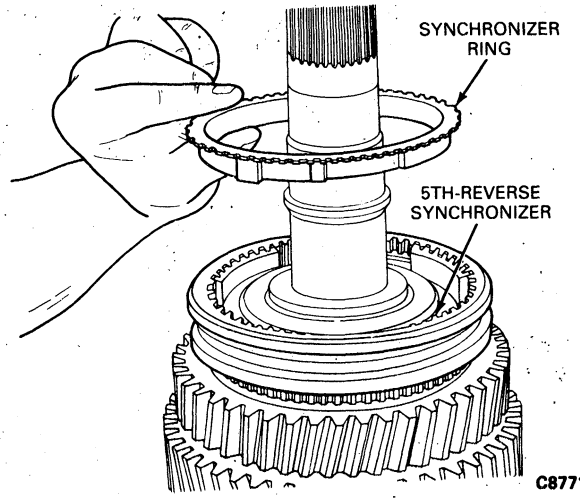
SUBASSEMBLIES (Continued)

20. Remove the 5th gear from the mainshaft.
21. Remove the 5th gear caged needle rollers from the mainshaft.



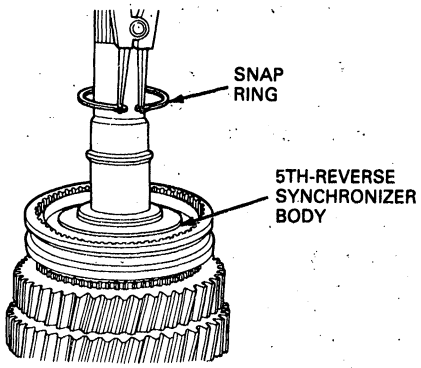
C8770-1A

22. Remove the synchronizer ring from the 5th-reverse synchronizer.



C8771-1A

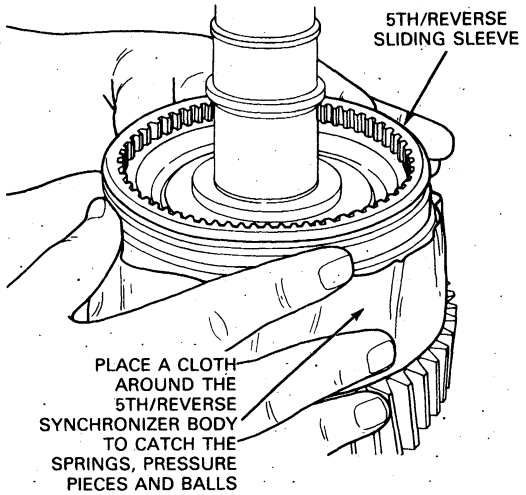
23. Remove the snap ring retaining the 5th-reverse synchronizer body to the mainshaft.



C8772-1A

24. Remove the 5th-reverse sliding sleeve.

CAUTION: Position a cloth around the 5th-rev synchronizer body to catch the springs, pressure pieces and balls that will be released when the sliding sleeve clears the 5th-rev synchronizer body.

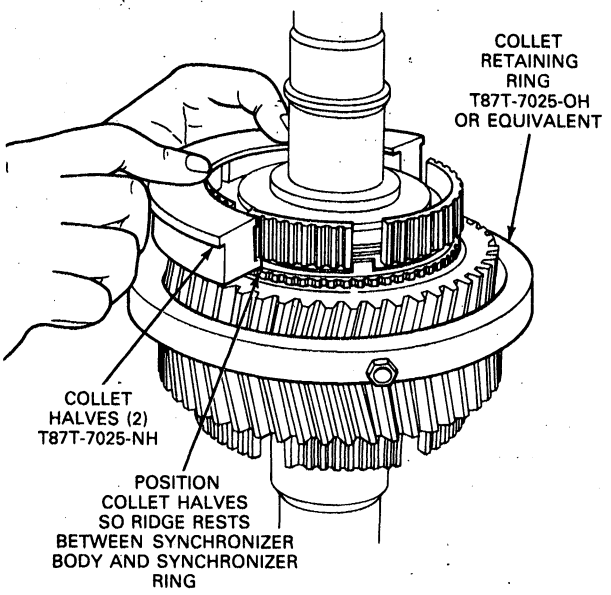


C8773-1A

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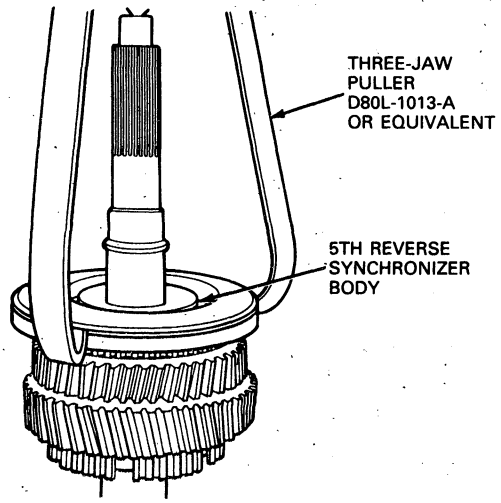
SUBASSEMBLIES (Continued)

25. Place the Collet Retaining Ring T87T-7025-OH or equivalent over the mainshaft and let it rest on the 1st gear. Position the collet halves T87T-7025-NH or equivalent so the ridge rests between the synchronizer body and the synchronizer ring. Slide the retaining ring upwards around the collets to secure them in position.



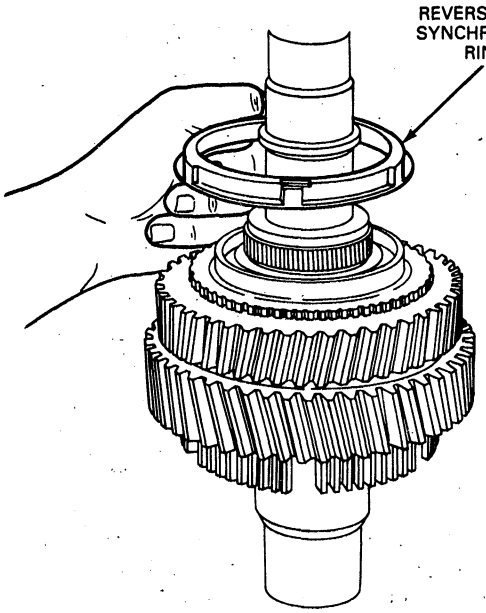
C8774-1A

26. Position a Three Jaw Puller D80L-1013-A or equivalent on the collet retaining ring and pull the 5th-Reverse synchronizer body from the mainshaft.



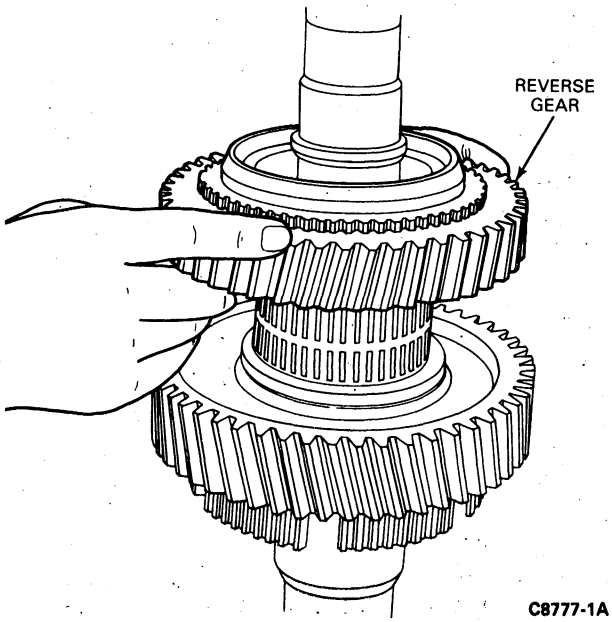
C8775-1A

27. Remove the synchronizer ring from the reverse gear.



C8776-1A

28. Remove the reverse gear from the mainshaft.

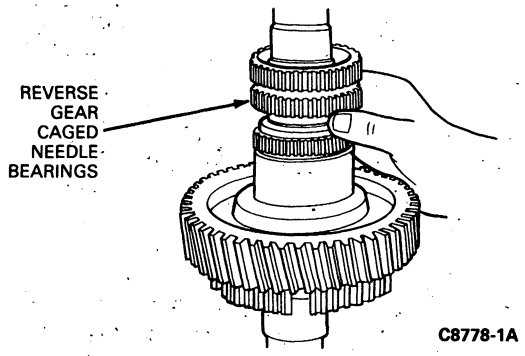


C8777-1A

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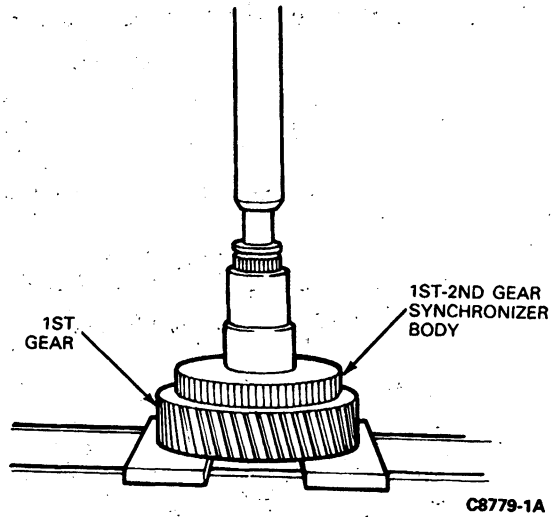
SUBASSEMBLIES (Continued)

29. Remove the reverse gear caged needle bearings from the mainshaft.

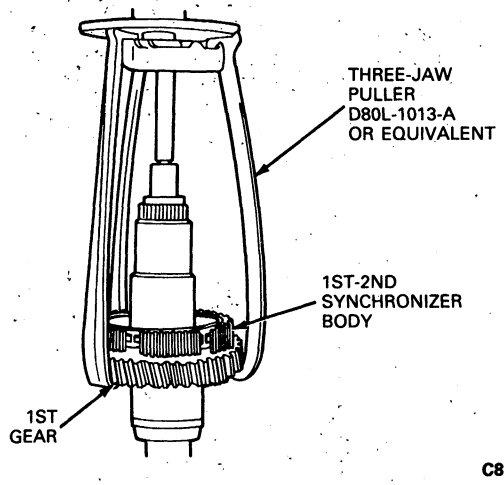


30. Remove the mainshaft from the vise. Position the mainshaft in a press as shown in the illustration and press the 1st gear and the 1st-2nd gear synchronizer body from the mainshaft.

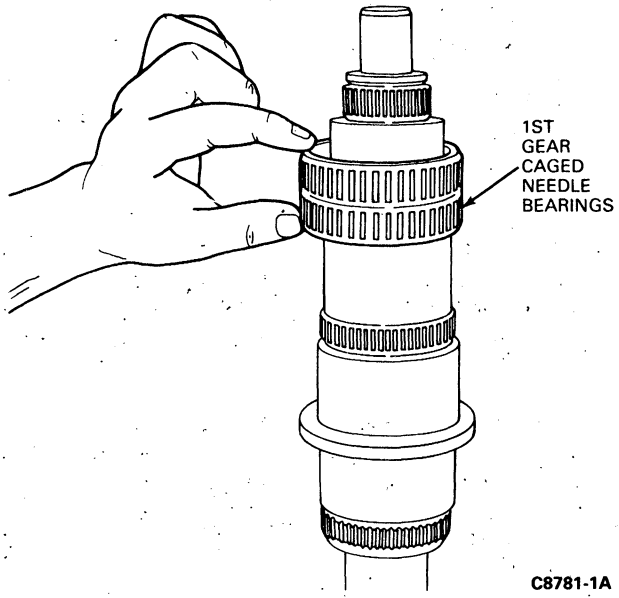
CAUTION: Make sure mainshaft is properly supported.



31. An alternate method is to turn the mainshaft over and clamp it at the output end. Position the jaws of Puller D80L-1013-A or equivalent on the 1st Gear and pull the 1st gear and the 1st-2nd synchronizer body from the mainshaft.



32. Remove 1st gear the caged needle rollers from the mainshaft.



Assembly

1. Clamp the input end of the main shaft in a vise.

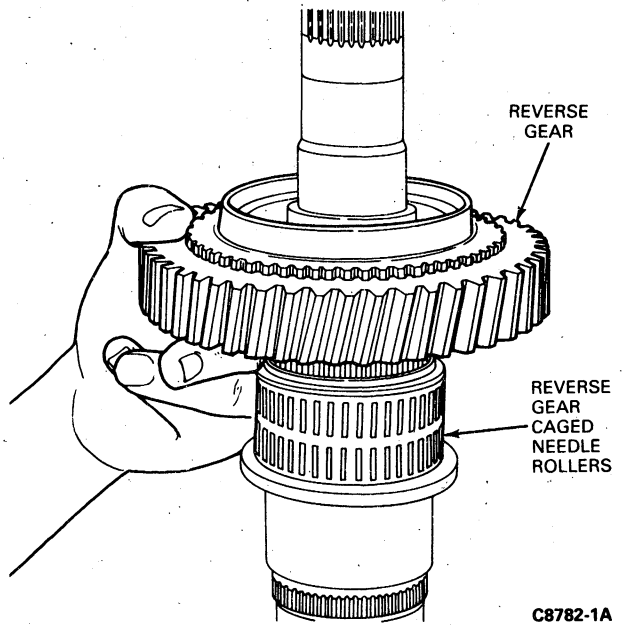
NOTE: Use brass pads or equivalent to prevent damage.

2. Place the reverse gear caged needle rollers on the mainshaft.
3. Place the reverse gear on the mainshaft over the caged needle rollers. The clutching teeth on the reverse gear must face upwards.

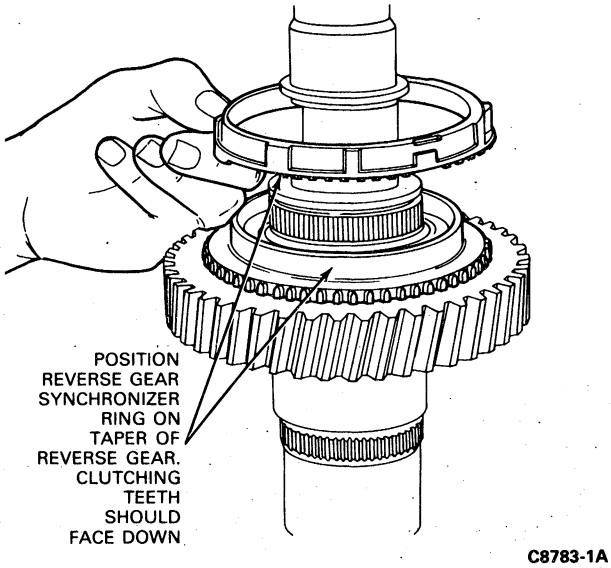
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SUBASSEMBLIES (Continued)

CAUTION: Before installing original synchronizer ring and synchronizer body, check for excessive wear. Refer to synchronizer ring/ synchronizer body wear check under inspection in this section for procedure.

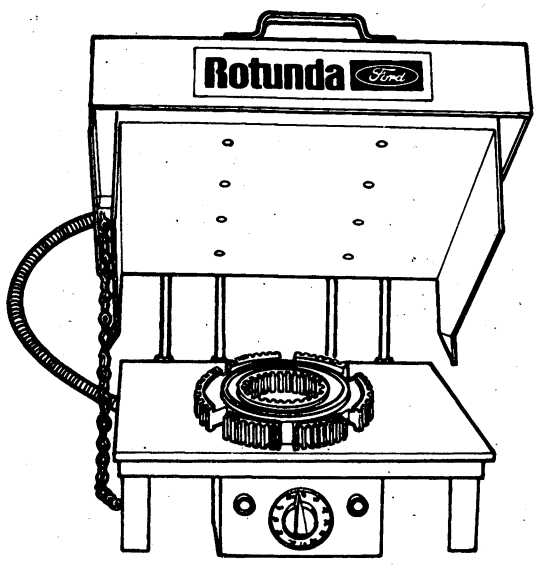


4. Position the reverse gear synchronizer ring on the taper of the reverse gear.

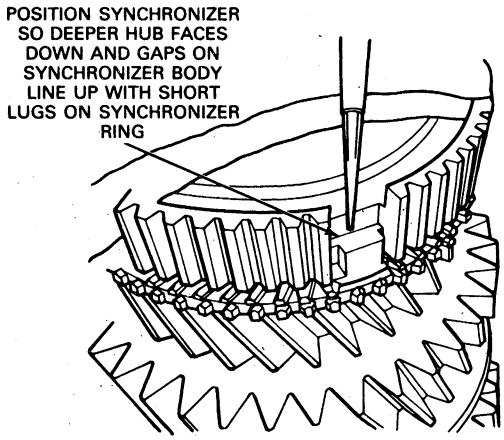


5. Heat the 5th-reverse synchronizer body with a Rotunda Gear Heater 130-00001, Heat Gun 107-00300 or equivalent to 160°C (320°F).

CAUTION: Do not heat synchronizer body for more than 15 minutes.



6. Position the synchronizer body on the mainshaft splines so that side with the deeper hub on faces down and the short lugs on the synchronizing ring engage in the gaps in the synchronizer body. Push or lightly tap the synchronizer body down until it stops.

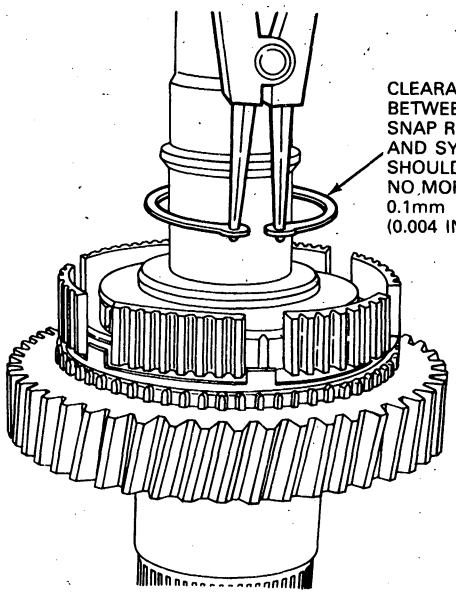


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SUBASSEMBLIES (Continued)

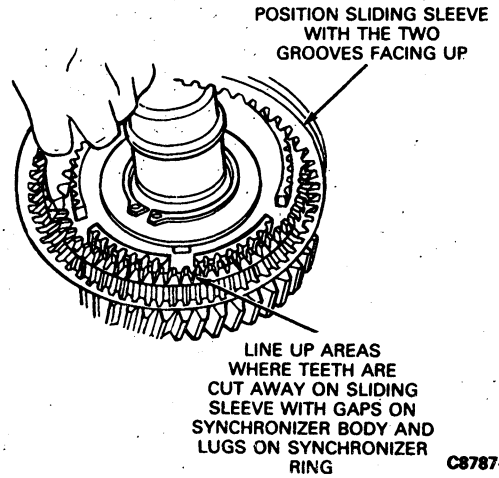
7. Install the snap ring on the mainshaft next to the 5th-reverse synchronizer body. The clearance between the snap ring and the synchronizer body should not be more than 0.1mm (0.004 inch) with zero clearance preferable.

CAUTION: Make sure snap ring is free of burrs before checking clearance.



C8786-1A

8. Check the reverse gear end play. End play must be between 0.15-0.35mm (0.006-0.014 inch).
9. There are two grooves on the 5th- reverse sliding sleeve. With the two grooves facing up, position the sliding sleeve over the synchronizer body. In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the reverse gear clutching teeth.

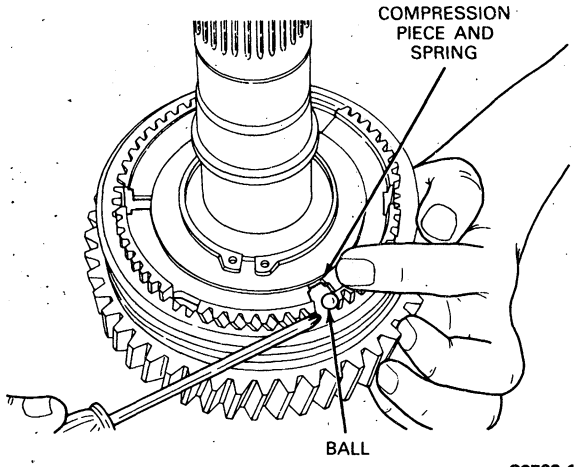


C8787-1B

10. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.

CAUTION: If the original springs are being replaced, inspect them before reuse. Refer to inspection in this section for procedure.

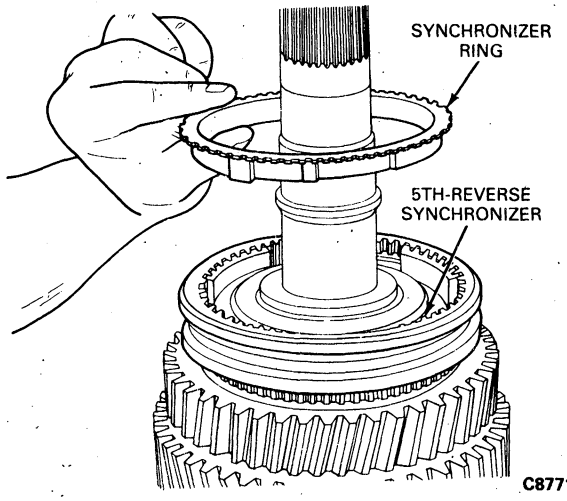
11. Push back the pressure pieces with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.



C8788-1A

12. Place the 5th gear synchronizer ring on the synchronizer body.

NOTE: The short lugs on the synchronizer ring should be located over the gaps in the 5th-reverse synchronizer body.

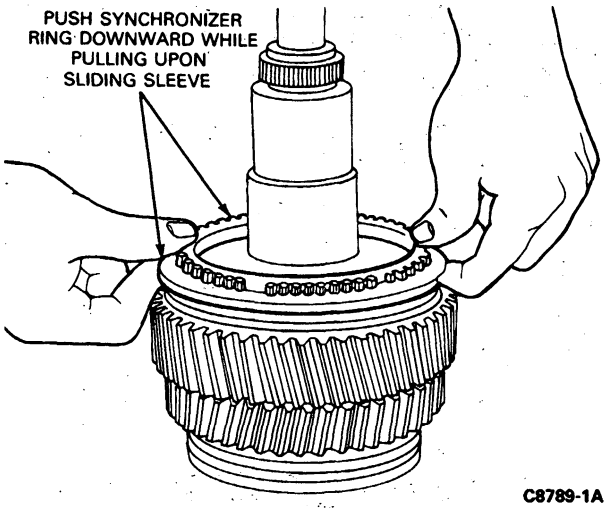


C8771-1A

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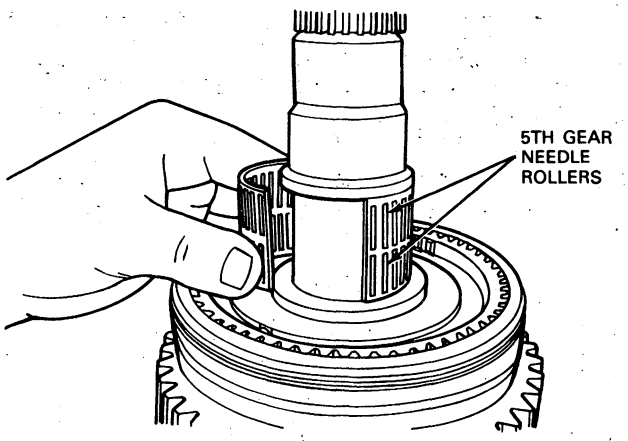
SUBASSEMBLIES (Continued)

13. Push the 5th gear synchronizer ring downwards while pulling the sliding sleeve into the center position.



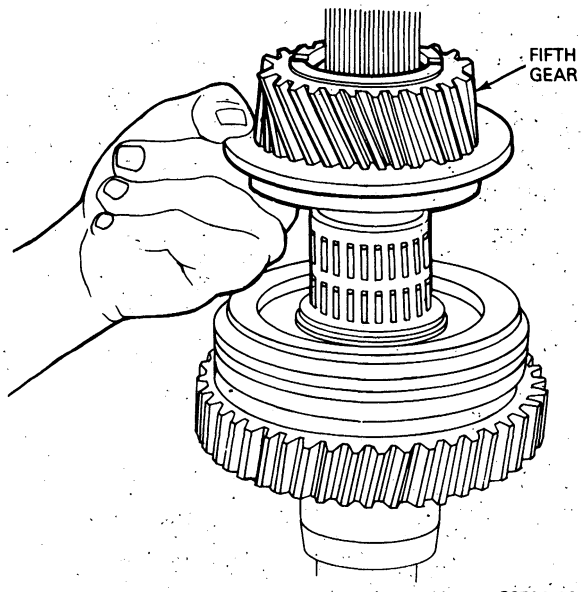
C8789-1A

14. Place both 5th gear caged needle rollers on the mainshaft.



C9024-1A

15. Install the 5th gear on the mainshaft over the caged needle rollers.



C8791-1A

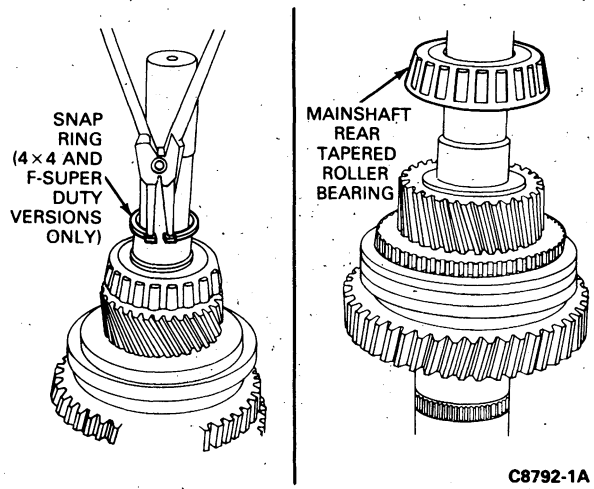
16. Heat the inner race of the mainshaft rear taper roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Place it on the main shaft and drive it on if necessary until it seats against its stop on the mainshaft.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.

17. Check the end play of the 5th gear. End play must be 0.006 to 0.014 in (0.15 to 0.35 mm).

NOTE: On 4x4 and F-Super Duty versions, fit an additional retaining ring in the annular groove adjacent to the taper roller bearing inner race. It must have an end play of 0.0-0.1mm (0.0-0.004 inch). 0mm (0.0 inch) should be aimed for.



C8792-1A

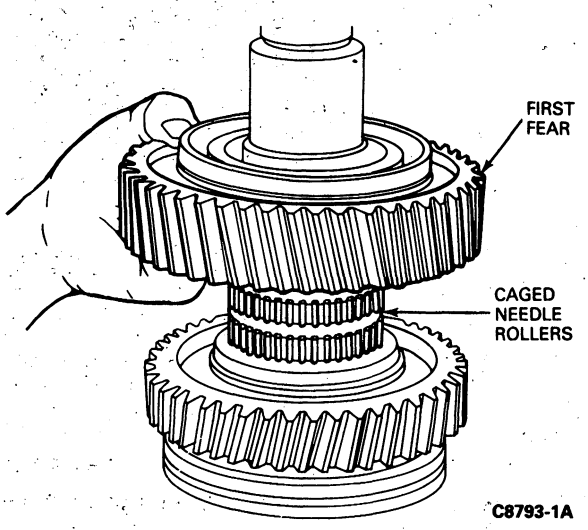
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SUBASSEMBLIES (Continued)

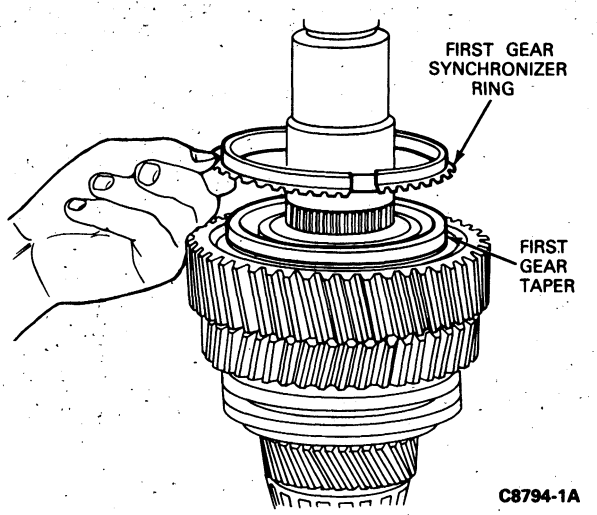
18. Turn the mainshaft over and clamp it at the input end.

NOTE: Use brass pads or equivalent to prevent damage.

19. Place the caged needle rollers for the 1st gear on the mainshaft.
20. Place the 1st gear over the needle rollers on the mainshaft with the taper facing up.

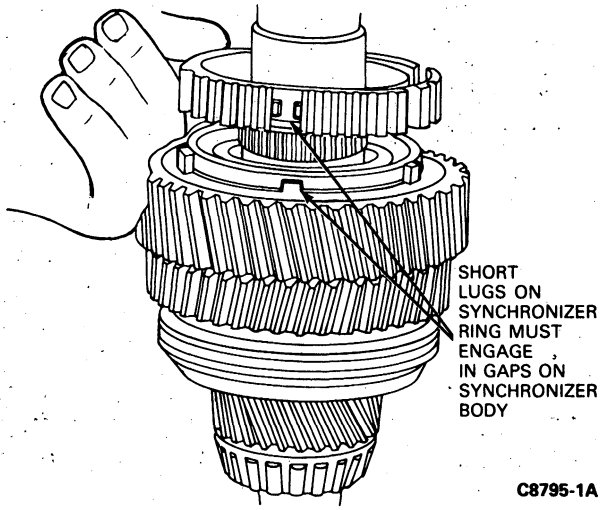


21. Place the 1st gear synchronizer ring on the taper of the 1st gear.



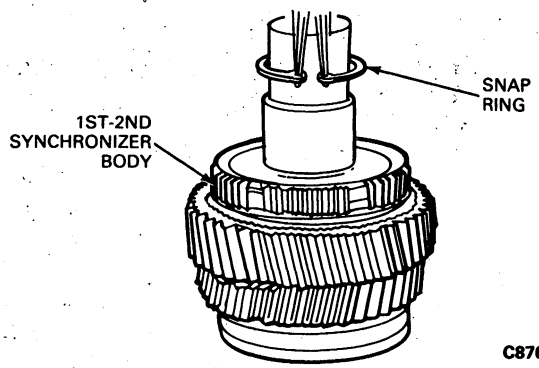
22. Heat the 1st-2nd synchronizer body to max. 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Position the synchronizer body on the mainshaft splines so that the short lugs on the synchronizing ring engage in the gaps in the synchronizer body. Push or lightly tap the synchronizer body down until it stops against the synchronizer ring. When proper installation is made, the word "ENGINE" will be visible on the synchronizer body.

CAUTION: Do not heat the synchronizer body for more than 15 minutes.



23. Install a snap ring on the mainshaft next to the 1st-2nd synchronizer body. Clearance between the snap ring and the synchronizer body should not be more than 0.1 mm (0.004 in).

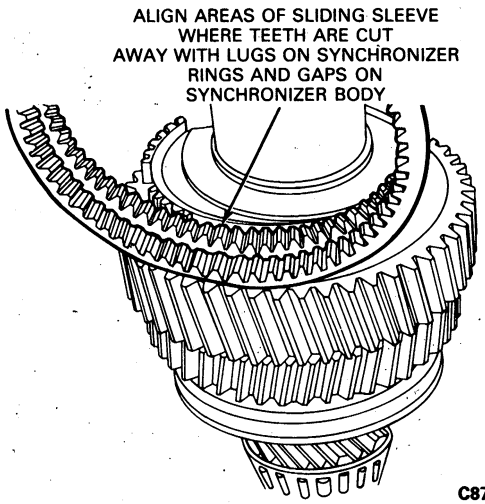
CAUTION: Make sure the snap ring is free of burrs before installing and measuring end play.



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SUBASSEMBLIES (Continued)

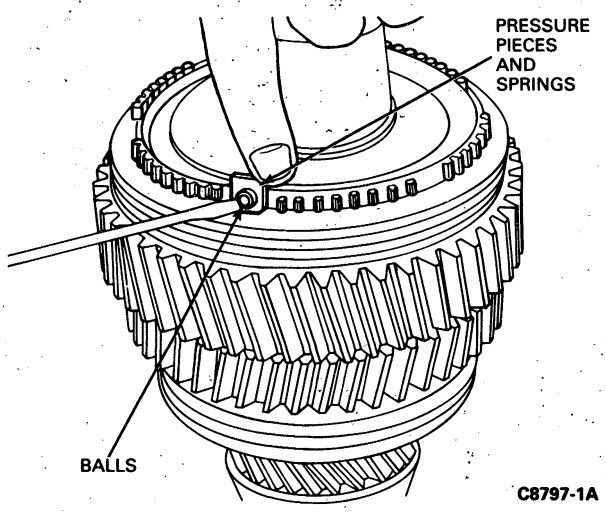
24. Check the end play of the 1st gear. It must be between 0.15 and 0.35 mm (0.006 and 0.014 in).
25. Position the sliding sleeve over the synchronizer body with its tapered collar facing down (towards the output end of the mainshaft). In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the 1st gear.



26. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.

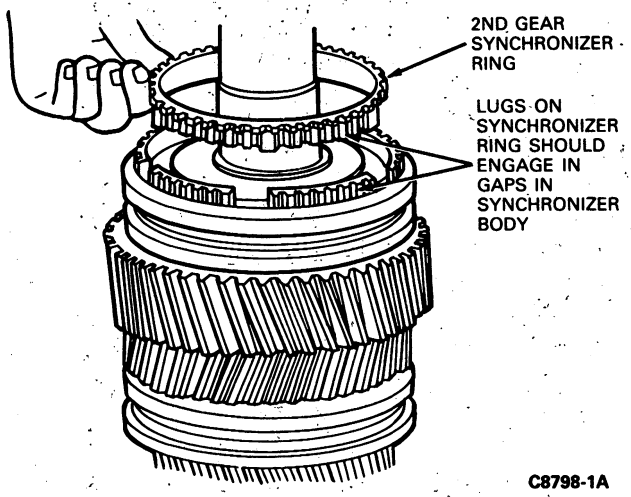
CAUTION: If the original springs are not being replaced, inspect them before reuse. Refer to inspection in this section for procedure.

27. Push back the pressure pieces with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.

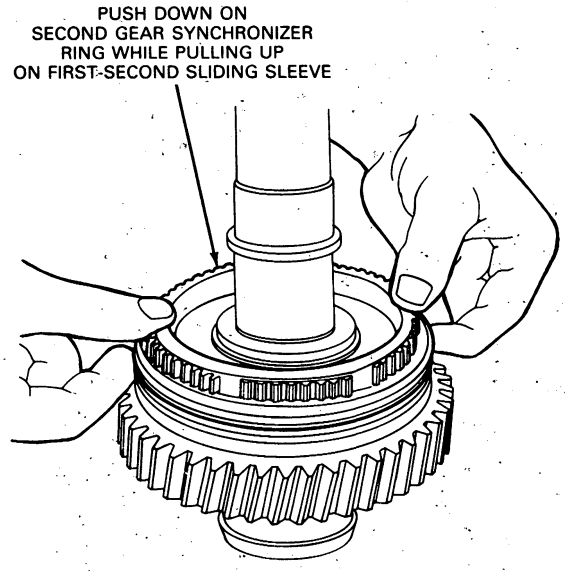


28. Place the 2nd gear synchronizer ring on the 1st-2nd synchronizer body.

NOTE: The short lugs on the synchronizer ring should be located over the gaps in the 1st-2nd synchronizer body.



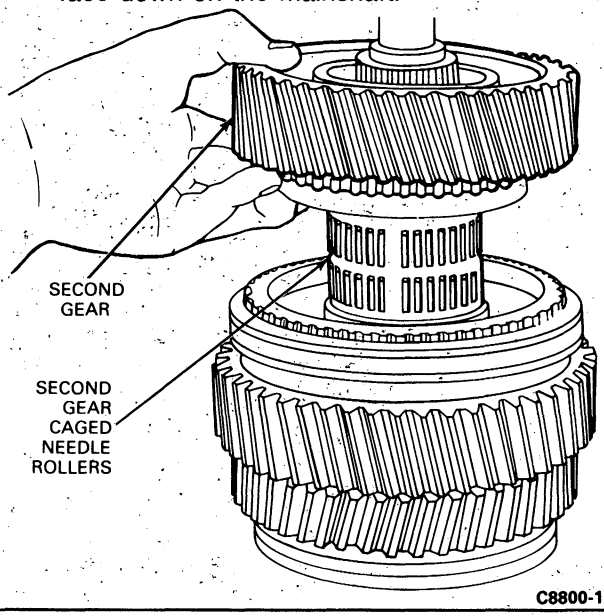
29. Push the synchronizer ring downwards while pulling the sliding sleeve into the center position.



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SUBASSEMBLIES (Continued)

30. Place the caged needle rollers for the 2nd gear on the mainshaft.
31. Place the 2nd gear over the needle bearings on the mainshaft. The taper of the 2nd gear must face down on the mainshaft.

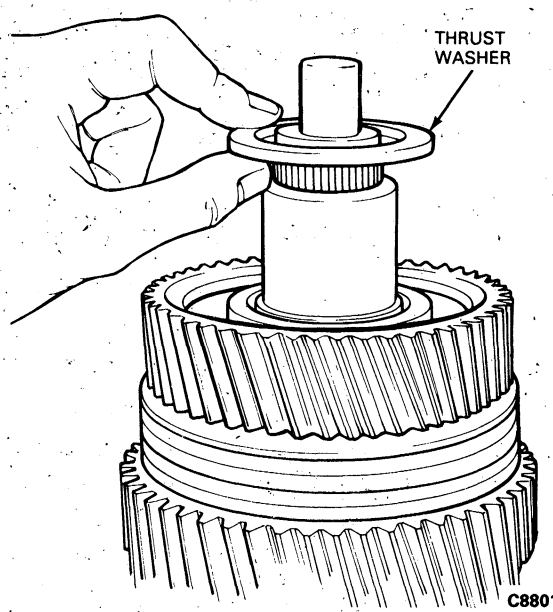


C8800-1A

32. Heat the thrust washer to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent.

CAUTION: Do not heat the washer for more than 15 minutes.

33. Place the thrust washer on the mainshaft and push it down until it seats against its stop on the shaft. If necessary, gently tap the washer to fully seat it.

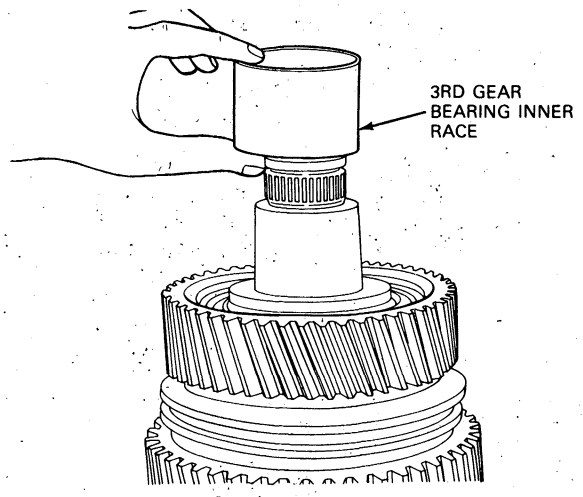


C8801-1A

34. Heat the 3rd gear bearing inner race to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent.

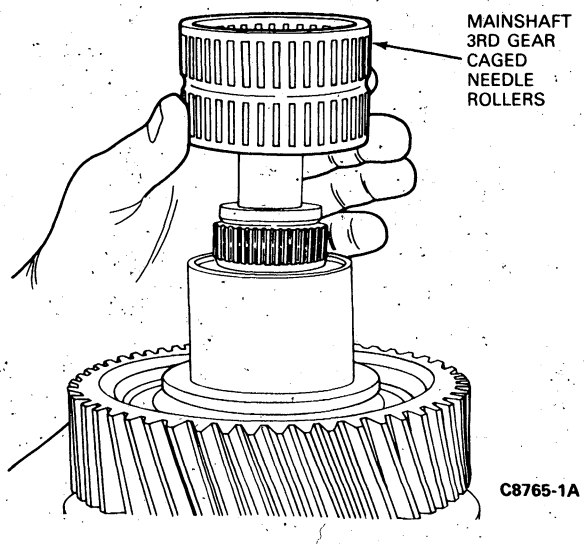
CAUTION: Do not heat the race for more than 15 minutes.

35. Place the race on the mainshaft and push it down until it seats against its stop on the shaft. If necessary, gently tap the race to fully seat it.



C8802-1A

36. Check the end play of the 2nd gear. It must be between 0.15-0.45mm (0.006-0.017 in).
37. After the 3rd gear bearing inner race has fully cooled, place the 3rd gear caged needle rollers over it.

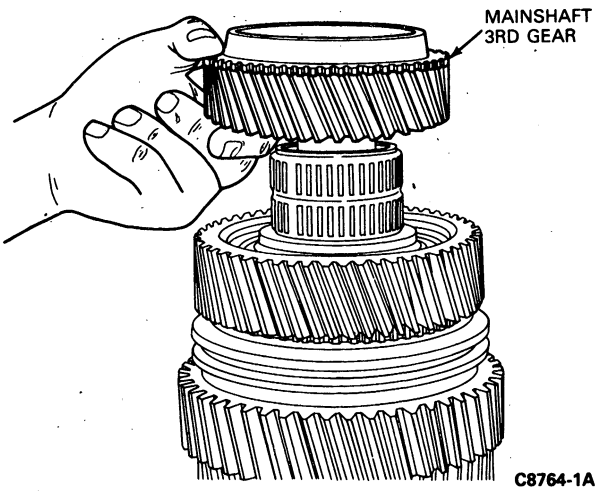


C8765-1A

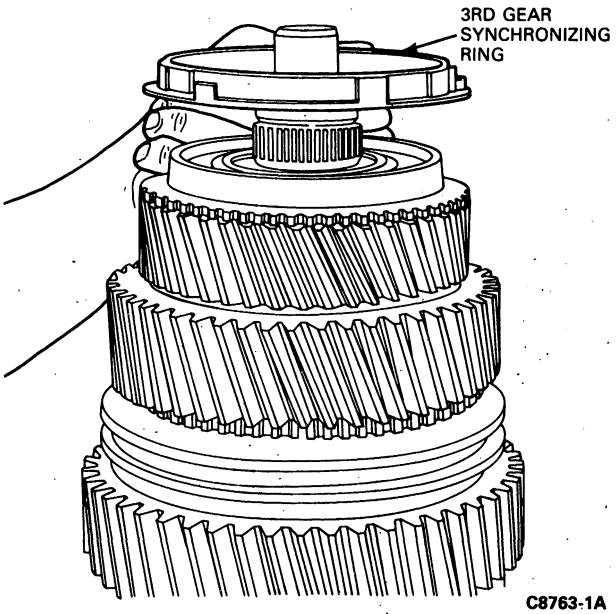
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SUBASSEMBLIES (Continued)

38. Place the 3rd gear over the needle rollers on the mainshaft. The taper of the 3rd gear must face up.

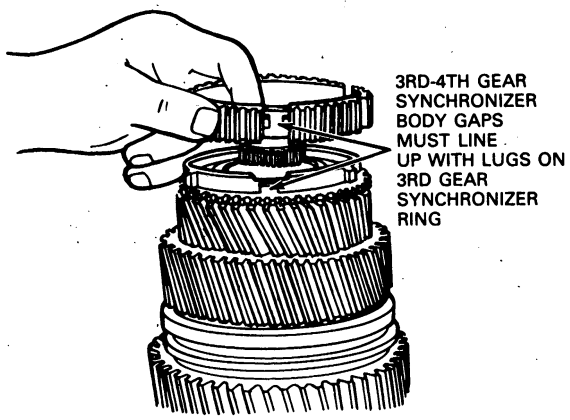


39. Place the 3rd gear synchronizer ring on the taper of the 3rd gear.



40. Heat the 3rd-4th synchronizer body with Rotunda Gear Heater 130-00001 or equivalent to max. 160°C (320°F). Position the synchronizer body on the mainshaft splines so that the short lugs on the synchronizing ring engage in the gaps in the synchronizer body. Push or lightly tap the synchronizer body down until it stops against the synchronizer ring. The recess in the synchronizer body must face upwards.

CAUTION: Do not heat the synchronizer body for more than 15 minutes.



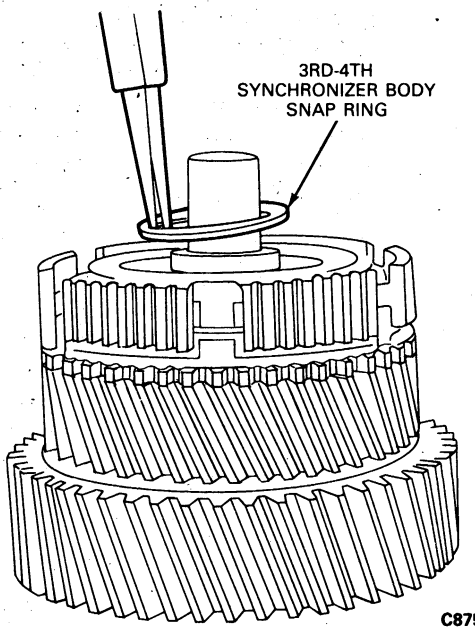
41. Install a snap ring on the mainshaft next to the 3rd-4th synchronizer body. Clearance between the snap ring and the synchronizer body should not be more than 0.1 mm (0.004 in).

CAUTION: Make sure the snap ring is free of burrs before installing and measuring end play.

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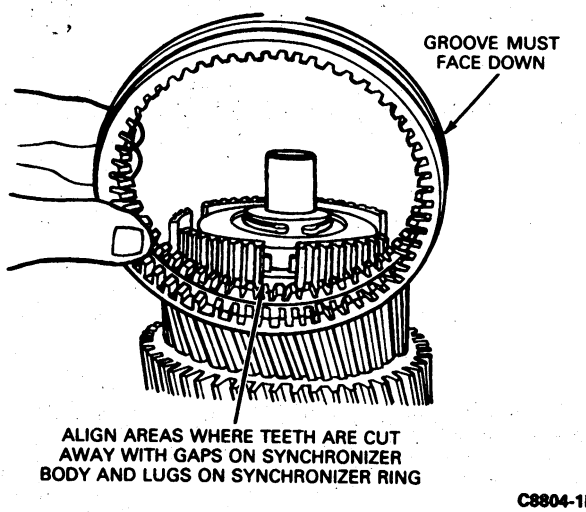
SUBASSEMBLIES (Continued)

42. Check the end play of the 3rd gear. It must be between 0.15 and 0.35 mm (0.006 and 0.014 in).



C8759-1A

43. Position the sliding sleeve over the synchronizer body with the smaller of the two grooves facing down. In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the 3rd gear.

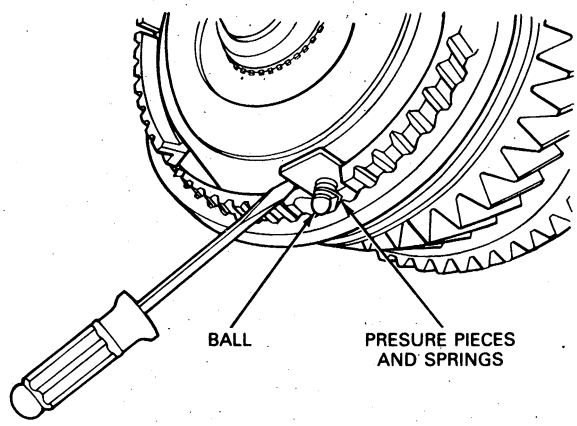


C8804-1B

44. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.

CAUTION: If the original springs are being replaced, inspect them before reuse. Refer to inspection in this section for procedure.

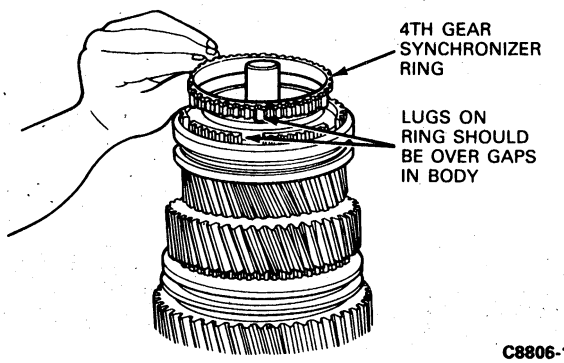
45. Push back the pressure pieces with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.



C8805-1A

46. Place the 4th gear synchronizer ring on the synchronizer body.

Note: The short lugs on the synchronizer ring should be located over the gaps in the 3rd-4th synchronizer body.

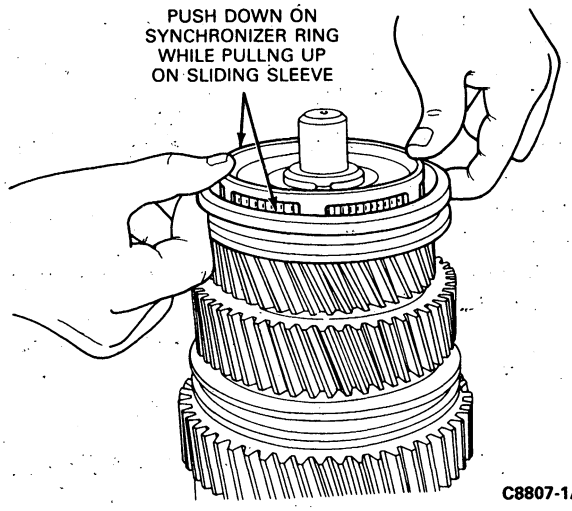


C8806-1A

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SUBASSEMBLIES (Continued)

47. Push the synchronizer ring downwards while pulling the sliding sleeve into the center position.

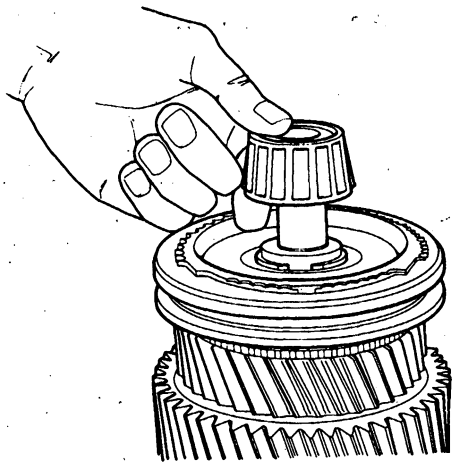


48. Heat the inner race of the mainshaft front taper roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Place it on the main shaft and drive it on if necessary until it seats against its stop on the mainshaft.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.

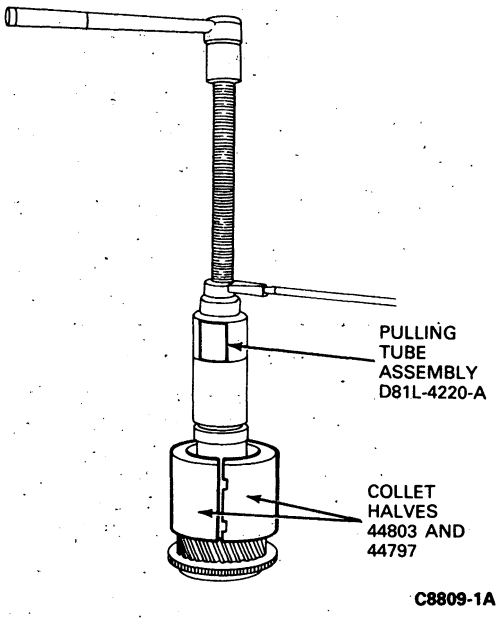
An alternate method is to press the bearing on using Bearing Cone Replacer T85T-4621-AH.



Input Shaft

Disassembly

1. Position the two Collet Halves (44803 and 44797) of the Universal Bearing Remover Set D81L-4220-A or equivalent around the input shaft bearing cone. Install the Pulling Tube Assembly on the collet halves and pull the input shaft bearing from the input shaft.



Assembly

CAUTION: Inspect the surface of the input shaft in the area of the bearing race to make sure it is smooth and free of burrs. Also inspect the condition of the guide splines.

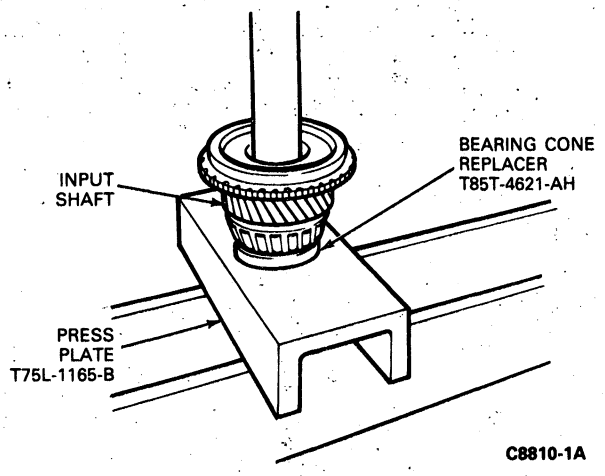
1. Place the bearing on the input shaft.
2. Place Bearing Cone Replacer T85T-4621-AH over the bearing.
3. Position the shaft, bearing, and bearing cone replacer in Press Plate T75L-1165-B as shown in the illustration.

CAUTION: Ensure that the pocket bearing oil baffle is fully installed and not damaged.

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SUBASSEMBLIES (Continued)

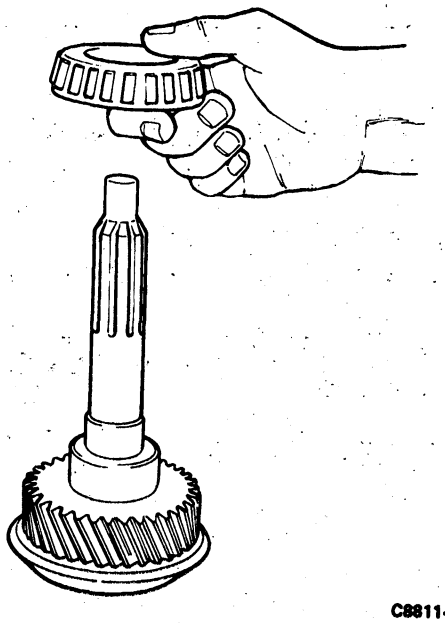
4. Press the bearing on until it seats against its stop on the shaft.



5. An alternate method is to heat the inner race of the input shaft tapered roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001, Heat Gun 107-00300 or equivalent and fit it on the input shaft. If necessary, use a suitable tool to seat the bearing against its stop.

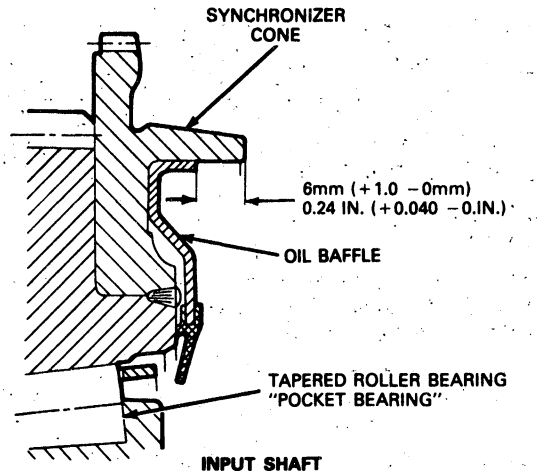
CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.



Any time the transmission is serviced check the following items:

- Confirm that the oil baffle is installed in the input shaft synchronizer cone recess.
- Visually inspect the oil baffle for tears or damage.
- The oil baffle lip is recessed 6mm (+1 -0) [0.24 in. (+0.04 - 0)] below the synchronizer cone edge.
- The oil baffle fits tight and cannot be moved by hand.
- The three lubrication holes in the input shaft are free of any obstruction.
- The oil channel (in the main case) to the input shaft bearing is free of any obstruction.
- The oil retainer ring (part of the shim pack) behind the outer race of the input bearing is free of damage.
- The synchronizer body snap ring forward of the 3/4 synchronizer package on the mainshaft is in position.



Countershaft

NOTE: Do not attempt service procedures on the countershaft. It is serviced as an assembly.

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SPECIFICATIONS

PRE-LOAD SPECIFICATIONS

Description	mm	Inches
Countershaft	0.02-0.11	0.00079-0.00434
Input Shaft and Main Shaft	0.02-0.11	0.00079-0.00434
Mainshaft Reverse Gear	0.15-0.35	0.00591-0.01378
Mainshaft 1st Gear	0.15-0.35	0.00591-0.01378
Mainshaft 2nd Gear	0.15-0.45	0.00591-0.01717
Mainshaft 3rd Gear	0.15-0.35	0.00591-0.01378
Mainshaft 4th Gear	0.15-0.35	0.00591-0.01378
Mainshaft Synchronizer Body Retention Rings	0-0.1	0-0.00394

CC8825-2A

TRANSMISSION LUBRICANT

Description	Liters	U.S. Qts.	Imp. Qts.
Motorcraft MERCON® Multipurpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent.	3.2	3.5	3.0

CC9018-1B

ROTUNDA EQUIPMENT

Model	Description
077-00006	Transmission Jack
107-00300	Heat Gun
130-00001	Gear Heater

CC8827-1B

SPECIAL TOOLS

T87T-7025-AH	Locknut Socket	T50T-100-A	Slide Hammer
T87T-7025-BH	Rear Seal Replacer	T80T-4000-W	Handle
T87T-7025-CH	Rear Seal Remover	T77F-1102-A	Bearing Cup Puller
T87T-7025-DH	Needle Bearing Replacer	T73T-4222-A	Bearing Cup Replacer
T87T-7025-EH	Front Seal Replacer	T84T-7025-B	Forcing Screw
T87T-7025-FH	Bearing Collets Pair	T77J-7025-B	Puller/Installer Tube
T87T-7025-HH	Gear Pack Holding Fixture	T75L-7025-G	Collet Retaining Ring
T87T-7025-JH	Shift Rod Support	T75L-4201-A	Alignment Adapter
T87T-7025-LH	Output Seal Replacer	T57L-500-B	Bench Mounted Holding Fixture
T87T-7025-MH	Puller Collets	T53T-4621-C	Differential Side Bearing Replacer
T87T-7025-NH	Puller Collets	T83T-6316-B	Crank/Cam Gear and Damper Replacer
T87T-7025-OH	Collet Retaining Ring	D81L-4220-A	Trans. Puller Set
T87T-7025-PH	Mainshaft Front Bearing Cup Replacer	D78P-4201-B	Dial Indicator
T78P-4851-A	Companion Flange Holder	D79L-4621-A	Bearing Splitter
D78P-4201-F	Dial Indicator Brackets	D80L-943-A	Internal Puller
T75L-1165-B	Press Plate	D80L-100-Q	Blind Hole Puller
T85T-4621-AH	Bearing Cone Replacer	D80L-1013-A	3 Way Puller
T57L-4621-B	Bearing Cone Replacer	D80L-625-4	Shaft Protector
D87L-1000-A	Lift Sling	TOOL-4201-C	Dial Indicator

CC8826-2B

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SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

Description	Quantity	Thread Description	Torque	
			N-m	Ft.-Lbs.
Drain Plug	1	M24x1.5	35-40	25-30
Oil Filler Plug	1	M24x1.5	35-40	25-30
Extension Adapter to Main Case	17	M8	22	16
End Yoke to Mainshaft	1	M24x1.25	250	184
Shift Tower Cover to Main Case	8	M8	22	16
P.T.O. Cover Plate			38	28
Idler Shaft Retention	2	M8	22	16
Shift Rail Plate	3	M6	10	7
Shift Cover to Tower Cover	3	M6	10	7
Reverse Switch	1	9/16-18NF	20	15

CC8828-2B

SPRING SPECIFICATIONS

	Length	Outer Diameter	Wire Diameter
Detent Springs	44.1 mm (1.736 in.)	7.880 mm (0.310 in.)	1.250 mm (0.049 in.)
Reverse Gear Stop Plate Spring	35.5 mm (1.398 in.)	9.040 mm (0.356 in.)	1.000 mm (0.039 in.)
Synchronizer Spring	14.8 mm (0.583 in.)	5.960 mm (0.235 in.)	0.950 mm (0.037 in.)

CC8829-2B

PRESS-OFF AND PRESS-ON PRESSURES AND MOUNTING TEMPERATURES

	Pressure		Temperature	
	kN	Lbs.	C	F
Taper Roller Bearing Inner Race	—	—	160	320
Synchronizer Bodies	—	—	160	320
Thrust Washer	—	—	160	320
Needle Bearing Inner Race	—	—	160	320
Bearing Outer Race in Cover	—	—	160	320
Ball Bearing Sleeve in Cover	—	—	160	320

CC8830-2A

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SECTION 16-80 Borg-Warner 13-56 Electronic Shift Transfer Case

SUBJECT	PAGE
DESCRIPTION	
Electronic Shift Control System	16-80-1
Transfer Case	16-80-1
DIAGNOSIS AND TESTING	
Eight-Wire Harness Connector	16-80-5
Electric Shift Operations	16-80-3
Five-Wire Harness Connector	16-80-4
Main Feed Connector Circuits	16-80-6
Mechanical Operations	16-80-3
Transfer Case Feed Harness Circuits	16-80-6
DISASSEMBLY AND ASSEMBLY	16-80-10
OPERATION	
Electronic Shift Control System	16-80-2
REMOVAL AND INSTALLATION	
Control Module	16-80-8
Electronic Shift Transfer Case	16-80-8
Rear Or Front Output Shaft Oil Seals	16-80-10
SPECIFICATIONS	16-80-23
VEHICLE APPLICATION	16-80-1

VEHICLE APPLICATION

Bronco (4x4) with Automatic Transmission Only.

DESCRIPTION

Transfer Case

The Borg-Warner 13-56 Electronic Shift Transfer Case is used on Bronco (4x4) vehicles with Automatic Transmission only. The transfer case transfers power from the transmission to the rear axle, and also to the front axle when electronically actuated.

Electronic Shift Control System

This system consists of a two rocker switch control system, an electronic control module, an electric shift motor with an integral shift position sensor, and a speed sensor.

Rocker Switch Control System

There are two rocker control switches located on the lower right hand corner of the instrument panel for fingertip shift control. The two switches are mounted horizontally and are identified as "4x4" and "low range". Two indicator bar lamps are located in the instrument cluster over the speedometer.

Electronic Control Module

The electronic control module, located on the right hand cowl side, controls the operation of the transfer case in response to inputs to the pushbutton control by the vehicle operator.

Speed Sensor

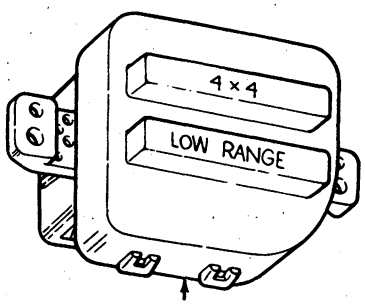
The speed sensor, mounted to the rear of the transfer case, tells the electronic control module the proper speed to shift the transfer case.

Shift Position Sensor

The shift position sensor, an integral part of the electric shift motor, tells the electronic control module the shift position of the transfer case.

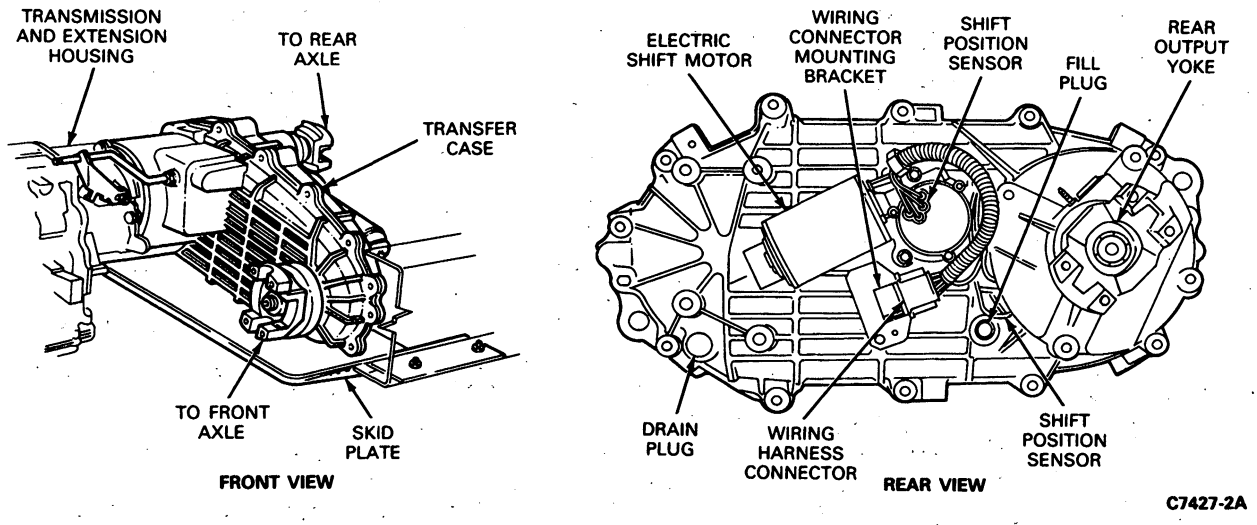
Electric Shift Motor

The electric shift motor, mounted externally at the rear of the transfer case, drives a rotary helical cam which moves the 2W-4W shift fork and 4H-4L reduction shift fork to the selected vehicle drive position.



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DESCRIPTION (Continued)



OPERATION

Mechanical Operation

In the 4x2 mode, torque from the transmission is transferred to the front input shaft, which in turn drives the rear output shaft that drives the rear axle.

The 2W-4W shift is accomplished when the 2W-4W shift fork moves the 2W-4W lockup collar to engage the front drive sprocket on the output shaft splines. The front drive sprocket turns the chain, which turns the front output shaft driven sprocket on the splined front output shaft and the front driveshaft.

The high-low shift is accomplished when the high-low shift fork moves the high-low lockup collar to engage the planetary gearset assembly to the output shaft. Torque from the input shaft is then transferred through the sun gear, which then turns the planetary gearset. The planetary gearset, which is now engaged to the output shaft, provides the gear reduction.

Electronic Shift Operation

The transfer case is equipped with a magnetic clutch, similar to an air conditioning compressor clutch, which is located inside the transfer case adjacent to the 2W-4W shift collar. The clutch is used to spin up the front drive system from zero to vehicle speed in milliseconds. This spin-up allows the shift between 2-high and 4-high to be made at any vehicle speed. When the transfer case rear and front output shafts reach synchronous speed, the spring loaded shift collar mechanically engages the mainshaft hub to the chain drive sprocket and the magnetic clutch is then deactivated. Shifts between 4-high and 4-low can only occur with the clutch interlock or transmission safety switches closed. The vehicle's speed must also be within specified limits as determined by the transfer case speed sensor (3 mph or under).

When the operator selects the drive combination through the pushbutton control, an electric motor turns a helical-cam, which is linked to the high-low and 2W-4W shift forks through fork-mounted roller bushing assemblies. As the electric motor turns the helical-cam, the high-low fork bushing rides in a slotted lobe in the cam to make the low-high or high-low range change; and the 2W-4W fork bushing rides on lobes at the end of the cam to make the 2W-4W or 4W-2W shift.

The unit is lubricated by a positive displacement oil pump that channels oil through the bores in the transfer case output shaft.

Electronic Shift Control System

In operation, when a control switch in the instrument panel is depressed, the Electronic Control Module will analyze information from the transfer case Shift Position Sensor to verify its current position. It also will analyze input information from the Speed Sensor and the Clutch Interlock Switch (or Neutral Safety Switch depending upon transmission application). If all the design conditions of the system are met, the Electronic Control Module will command the Electric Shift Motor to execute the desired function. After the shift takes place and the motor is turned off, the Electronic Control Module will again look at the inputs from the Shift Position Sensor to determine if the transfer case is in the position that the operator selected. Finally, the Electronic Control Module will illuminate the shift indication bar lamps located below the instrument cluster to indicate that the desired function has been completed.

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DIAGNOSIS AND TESTING

Mechanical Operations

For mechanical diagnosis and testing procedures, refer to Section 16-10, General Manual Transmission Service.

Electric Shift Operations

If the system operates improperly, or will not operate at all, a problem could exist in a control switch, the Electronic Control Module, the Speed Sensor, the Electric Shift Motor, the Electro-Magnetic Clutch Assembly or the interconnecting wiring.

Use the following guidelines and test procedures to assist in locating the cause of a problem.

Circuit Protection

The battery feed circuit, through a circuit breaker, provides memory capability for the electronic control module.

Ignition "RUN" and "ACC" feed circuits, through a fuse, provide power for the switches and the electric shift motor.

The headlamp dimmer circuit provides power for nighttime illumination of the switches located in the instrument panel.

Control Module Self-Test

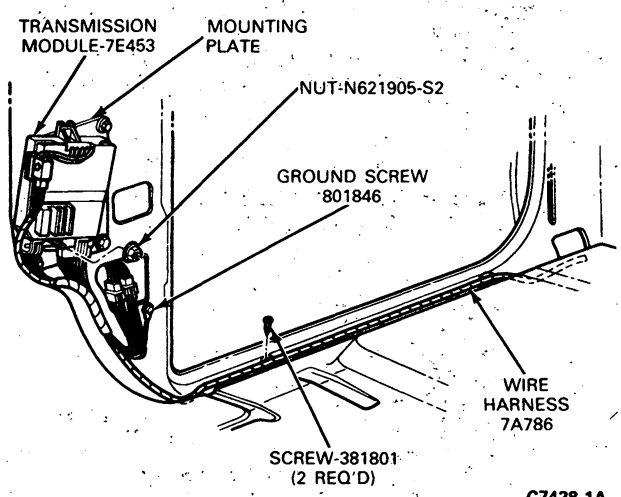
The Electronic Control Module has a diagnostic capability of its own circuitry. The self-test procedure is as follows:

1. Remove the Five-Wire Connector and the Eight-Wire Connector from the Electronic Control Module.
2. Turn the ignition switch to the "RUN" position.
3. Activate the Self-Test switch and note the result: A flashing indicator lamp (approximately one flash per second) indicates that the control module is functioning properly. A steady indicator lamp indicates that the control module is inoperative and must be replaced.

Control Module Circuits

There are three wiring harnesses connected to the Electronic Control Module: the Eight-Wire Pigtail Harness Connector; the Five-Wire Harness Connector; and the Eight-Wire Harness Connector.

To check the integrity of these circuits, disconnect the harnesses from the Electronic Control Module and perform the following checks:



Eight-Wire Pigtail Harness Connector

1. Connect a voltmeter between terminal 8 and ground. The voltmeter should indicate battery voltage at all times.
2. Connect a voltmeter between terminal 7 and ground. Then turn the ignition switch to the "RUN" position. The voltmeter should then indicate battery voltage.

CAUTION: In the following sections where the usage of an ohmmeter is specified, always remember that an ohmmeter should NEVER be connected into a "live" or powered circuit. If the ohmmeter is subjected to a powered circuit, severe damage will be done to the instrument. The vehicle's battery should be disconnected before performing checks on any circuit with an ohmmeter to prevent any accidental damage to the instrument.

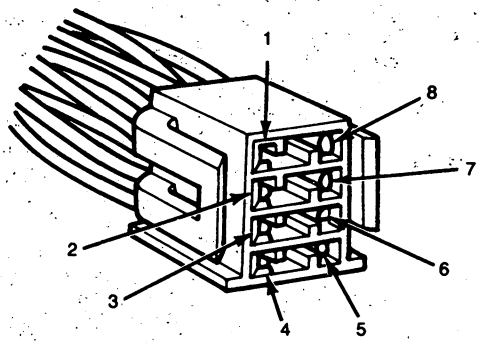
3. Connect an ohmmeter Rotunda Number 007-00001 between terminal 6 and ground. The ohmmeter should indicate a "low" resistance value (less than 10 ohms).

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DIAGNOSIS AND TESTING (Continued)

4. Connect an ohmmeter between terminals 4 and 5 of the wiring harness connector. The ohmmeter should indicate a "low" resistance value (less than 10 ohms).
5. Connect an ohmmeter between terminal 3 and ground. The ohmmeter should indicate 0 ohms.
6. Connect an ohmmeter between terminal 2 and ground. The ohmmeter should indicate 0 ohms.

EIGHT-WIRE PIGTAIL HARNESS CONNECTOR (E25B-14489-GB)



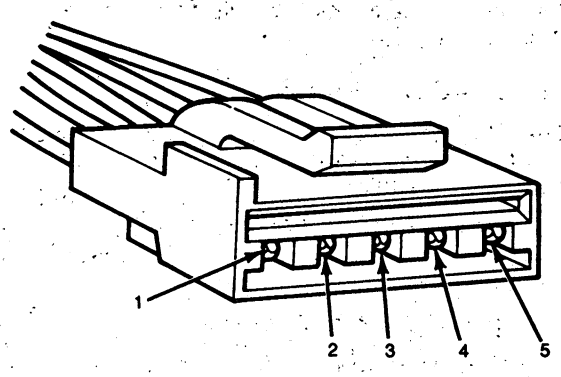
Position	Circuit Number	Color Code	Function
1	OPEN		
2	57	Blk	Ground
	57A	Blk	Ground
3	396	Blk/Org	Logic Ground
4	778	Org	Transfer Case Motor Control (Clockwise) 2H-4H-4L
5	777	Yel	Transfer Case Motor Control (Counterclockwise) 4L-4H-2H
6	779	Brn	Electro-Magnetic Clutch (Feed)
7	296	Wht/Ppl	Ignition Run and Accessory Feed (Fused)
8	517	Blk/Wht	Battery Feed (Circuit Breaker)

CC6599-1A

Five-Wire Harness Connector

1. Connect an ohmmeter between terminals 1 and 2. Then depress the 4x4 (2H-4H) switch in the Overhead Roof Console. The ohmmeter should indicate a very "low" resistance value (less than 50 ohms) while the switch is being depressed.
2. Connect an ohmmeter between terminals 1 and 3. Then depress the "Low Range" switch to the right of the steering column. The ohmmeter should indicate a very "low" resistance value (less than 50 ohms) while the switch is being depressed.
3. Connect a test lead between terminal 4 and ground. Turn the ignition switch to the "RUN" position and observe the Overhead Roof Console. The lamp in the Overhead Roof Console Low Range Bar should illuminate.
4. Connect a test lead between terminal number five and ground. Turn the ignition switch to the "RUN" position and observe the Overhead Roof Console. The lamp in the Overhead Roof Console 4x4 Bar should illuminate.

FIVE-WIRE HARNESS CONNECTOR (D5LB-14489-CA)



Position	Circuit Number	Color Code	Function
1	465	Wht/Lt Blu	Switch Feed
2	780	Dk Blu	4x4 Switch
3	781	Org/Lt Blu	Low Range Switch
4	782	Brn/Wht	Low Range Light
5	783	Gry	4x4 Light

CC6600-1A

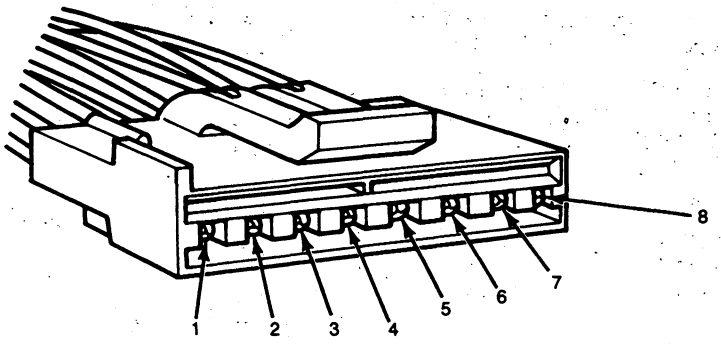
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DIAGNOSIS AND TESTING (Continued)

Eight-Wire Harness Connector

1. Connect an ohmmeter between terminal 1 and ground. On a vehicle equipped with a manual transmission, depress the clutch pedal and observe the ohmmeter. The ohmmeter should indicate a "low" resistance (less than 50 ohms) while the clutch pedal is being depressed. If the vehicle is equipped with an automatic transmission, shift the transmission into the "NEUTRAL" position and observe the ohmmeter. The ohmmeter should indicate a "low" resistance (less than 50 ohms) while the transmission selector lever is in the "NEUTRAL" position.
2. Connect an ohmmeter between terminals 2 and 3. The ohmmeter should indicate a "low" resistance reading (200-350 ohms). This will check the continuity of the speed sensor that is located in the transfer case. The speed sensor picks up the rotating speed of the output shaft from two notches that are cut in opposite sides of the outer ring of the clutch housing assembly.
3. Connect an ohmmeter between terminal 8 and terminals 4, 5, 6, and 7, respectively. Refer to the chart below for the appropriate ohmmeter readings in each transfer case position.

EIGHT-WIRE HARNESS CONNECTOR (E4EB-14489-SA)



Position	Circuit Number	Color Code	Function
1	32	Red/Lt Blu	Manual Transmission Clutch Interlock Switch
	463	Red/Wht	Automatic Transmission Neutral Safety Switch
2	774	Lt Grn	Speed Sensor (Feed)
3	772	Lt Blu	Speed Sensor Return
4	771	Violet	Wire #5, Contact Plate Position Sensor in Transfer Case
5	770	Wht	Wire #4, Contact Plate Position Sensor in Transfer Case
6	764	Brn/Wht	Wire #3, Contact Plate Position Sensor in Transfer Case
7	763	Org/Wht	Wire #2, Contact Plate Position Sensor in Transfer Case
8	762	Yel/Wht	Wire#1, Contact Plate Position Sensor in Transfer Case

OHMMETER READINGS FOR SHIFT MOTOR POSITION SENSOR

Ohmmeter Connection	Transfer Case Gear Position		
	2 High	4 High	4 Low
Meter Reading From Terminal #8 to #4	Short	Open	Short
Meter Reading From Terminal #8 to #5	Open	Open	Short
Meter Reading From Terminal #8 to #6	Short	Short	Open
Meter Reading From Terminal #8 to #7	Open	Short	Open

NOTE: SHORT is a "low" resistance reading on the ohmmeter (zero ohms).
OPEN is a "high" resistance reading on the ohmmeter (infinity).

CC6601-2A

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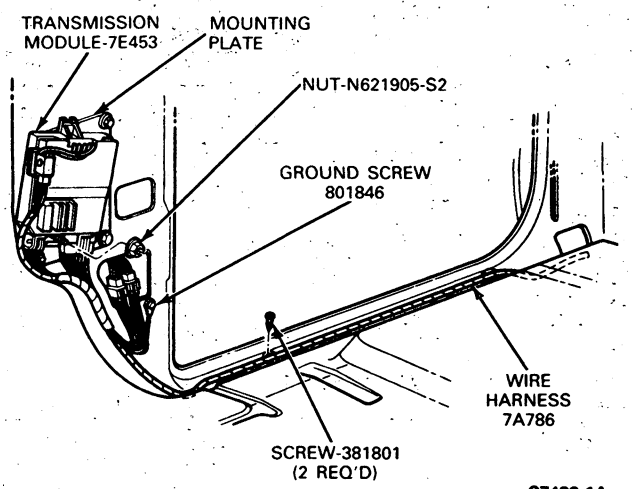
DIAGNOSIS AND TESTING (Continued)

Main Feed Connector Circuits

The Electronic "Touch Drive" Four Wheel Drive System Main Feed Connector to the instrument panel harness connector is located near the middle of the instrument panel.

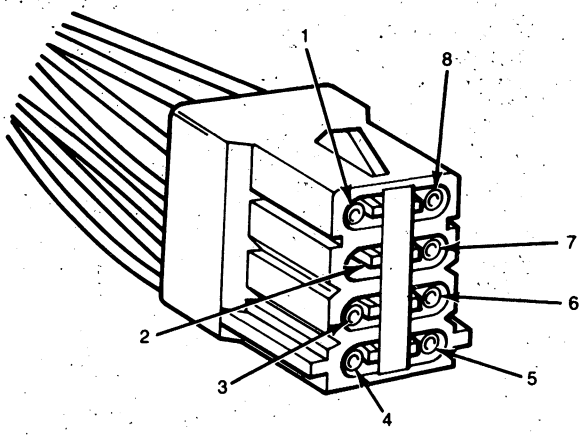
This connector contains the following inputs to the system:

1. The battery feed circuit through a circuit breaker provides memory capability for the electronic control module.
2. Ignition "RUN" and "ACC" feed circuits through a fuse provide power for the switches and the electric shift motor.
3. Dome lamp feed circuits provide power for the reading and map lamps.
4. The side marker lamp feed circuit provides power for nighttime illumination of the overhead roof console vehicle graphics.
5. Transmission interlock and safety switch feed circuits provide input to the control module to help determine whether or not the "Low Range" position can be selected.
6. The chassis ground circuit provides grounding capability for all of the system components except for the "logic ground" of the control module, which is grounded separately.



C7428-1A

MAIN FEED CONNECTOR (D9TB-14489-AA)

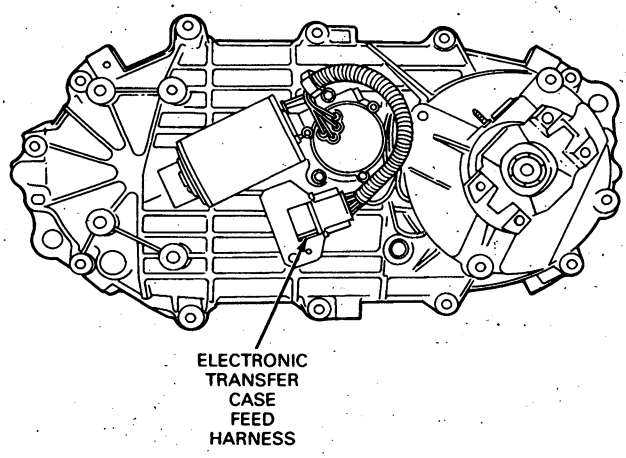


Position	Circuit Number	Color Code	Function
1	640	Red/Yel	Ignition Run and Accessory Feed (Fused)
2 (Used Only on Auto Trans)	463	Red/Wht	Automatic Transmission Neutral Safety Switch
3	296	Wht/Ppl	Ignition Run and Accessory Feed (Fused)
4	57	Blk	Ground
5	19	Lt Blu/Red	Side Marker Lamp (Feed)
6	54	Lt Grn/Yel	Dome Lamp (Feed)
7 (Used Only on Manual Trans)	52	Red/Lt Blue	Manual Transmission Clutch Interlock Switch
8	517	Blk/Wht	Battery Feed (Circiut Breaker)

CC7429-1B

Transfer Case Feed Harness Circuits

The electric transfer case feed harness contains ten wires that carry a variety of information to and from the electronic control module.



C7430-1A

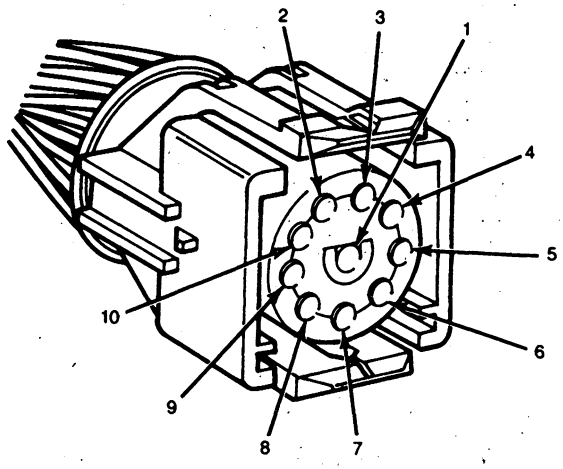
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DIAGNOSIS AND TESTING (Continued)

A listing of the transfer case feed harness circuits and their functions follows:

1. The electro-magnetic clutch feed circuit provides a power signal to the clutch coil, from the control module when shifting from 2W to 4W drive.
2. Clockwise rotation of the electric shift motor circuit provides power to drive the shift motor through the 2H-4H-4L sequence. If a position is selected that would require a shift through an intermediate position, the module will respond as if each intermediate position was selected, even if the 4L position was commanded from 2H. It will then fulfill all of the requirements for shifting into or out of each intermediate position.
3. Counterclockwise rotation of the electric shift motor circuit provides power to drive the shift motor through the 4L-4H-2H sequence. Actuation of the Low Range Switch, while in 4L, will cause a shift to 4H. Actuation of the "Four-by-Four" 2W-4W switch, after a shift to 4H from 4L, will then cause a shift to 2H.
4. The speed sensor coil feed circuit provides a constant signal from the electronic control module to the speed sensor located in the transfer case.
5. The speed sensor coil return circuit provides a varying signal (while the vehicle is in motion) from the speed sensor to the electronic control module. This signal indicates the vehicle speed to the microprocessor so that it can control the application of the "Low Range" gear selection in the transfer case.
6. The shift position sensor feed circuit provides a power signal from the Electronic Control Module to the shift position sensor to energize the sensor.
7. Shift position sensor return circuits provide the output information signals from the transfer case to the electronic control module. This information gives the control module the correct position of the shaft that turns the helical cam in the transfer case.

ELECTRONIC TRANSFER CASE FEED HARNESS (E4DB-14489-AA)



Position	Circuit Number	Color Code	Function
1	779	Brn	Electro-Magnetic Clutch (Feed)
2	778	Org	Transfer Case Motor Control (Clockwise) 2H-4H-4L
3	777	Yel	Transfer Case Motor Control (Counterclockwise) 4L-4H-2H
4	774	Lt Grn	Speed Sensor (Feed)
5	772	Lt Blu	Speed Sensor (Return)
6	771	Violet	Wire #5, Shift Position Sensor in Transfer Case (Output to Module)
7	770	Wht	Wire #4, Shift Position Sensor in Transfer Case (Output to Module)
8	764	Brn/Wht	Wire #3, Shift Position Sensor in Transfer Case (Output to Module)
9	763	Org/Wht	Wire #2, Shift Position Sensor in Transfer Case (Output to Module)
10	762	Yel/Wht	Wire #1, Shift Position Sensor in Transfer Case (Input from Module)

CC6608-1A

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REMOVAL AND INSTALLATION

4X4 Shift Switch

Removal and Installation

1. Remove the instrument panel assembly as described in that Section 45-61 Instrument Panel and Pad.
2. Remove the switch mounting screw and remove the switch from the panel.
3. To install, position the switch in the panel and retain with mounting screw.
4. Install the instrument panel assembly.

Control Module

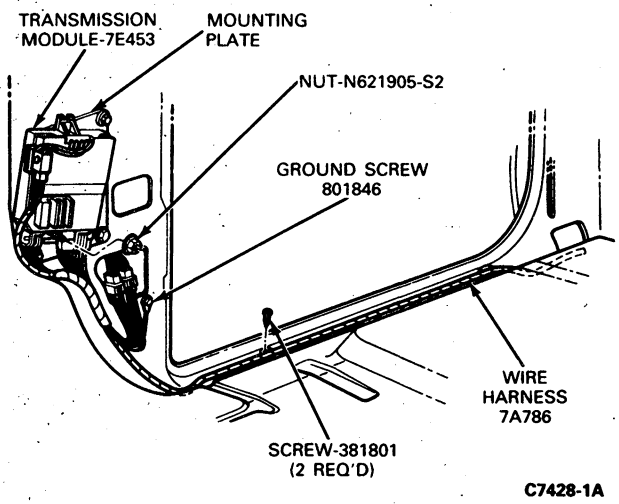
The electronic control module is located on the inside right hand cowl panel.

Removal

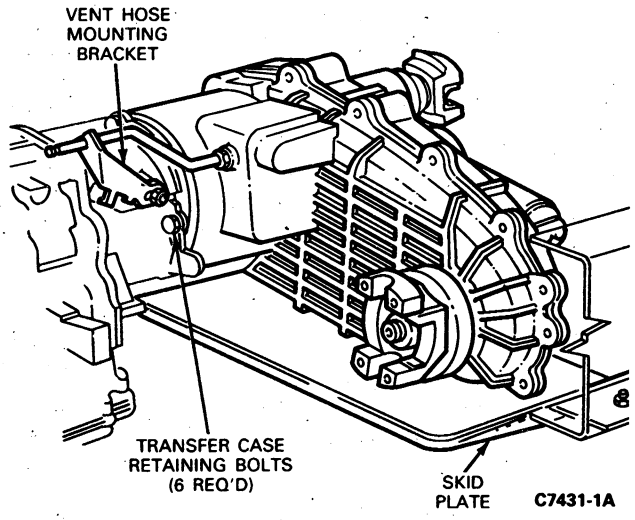
1. Remove the right hand cowl panel kick pad.
2. Remove the two module to instrument panel attaching screws.
3. Lift out the module and disconnect the three wiring connectors. Remove module assembly.

Installation

1. Position module to the instrument panel opening. Connect the three wiring connectors to the module.
2. Place module into the instrument panel opening and install the two attaching screws.
3. Install the instrument panel pad.



Electronic Shift Transfer Case



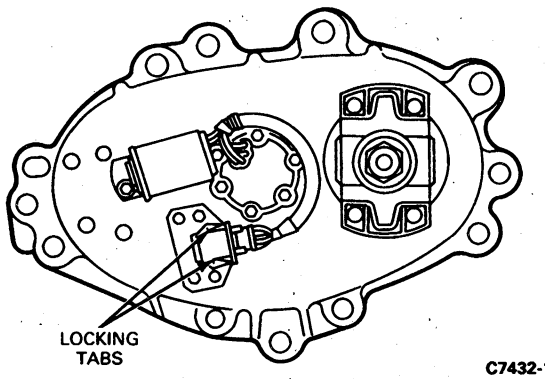
Removal

1. Raise the vehicle on a hoist.
2. If so equipped, remove the nuts, bolts and skid plate from the frame.
3. Place a drain pan under the transfer case. Remove the drain plug and drain the fluid from the transfer case.
4. Remove the wire connector from the feed wire harness at the rear of the transfer case. First squeeze the locking tabs, then pull the connectors apart.

CAUTION: Do not pull directly on the wires.

NOTE: For detailed instructions on front and rear driveshaft removal, refer to the appropriate driveshaft Section in Group 15.

5. Disconnect the front driveshaft from front output shaft yoke.
6. Disconnect the rear driveshaft from the transfer case rear output shaft yoke.



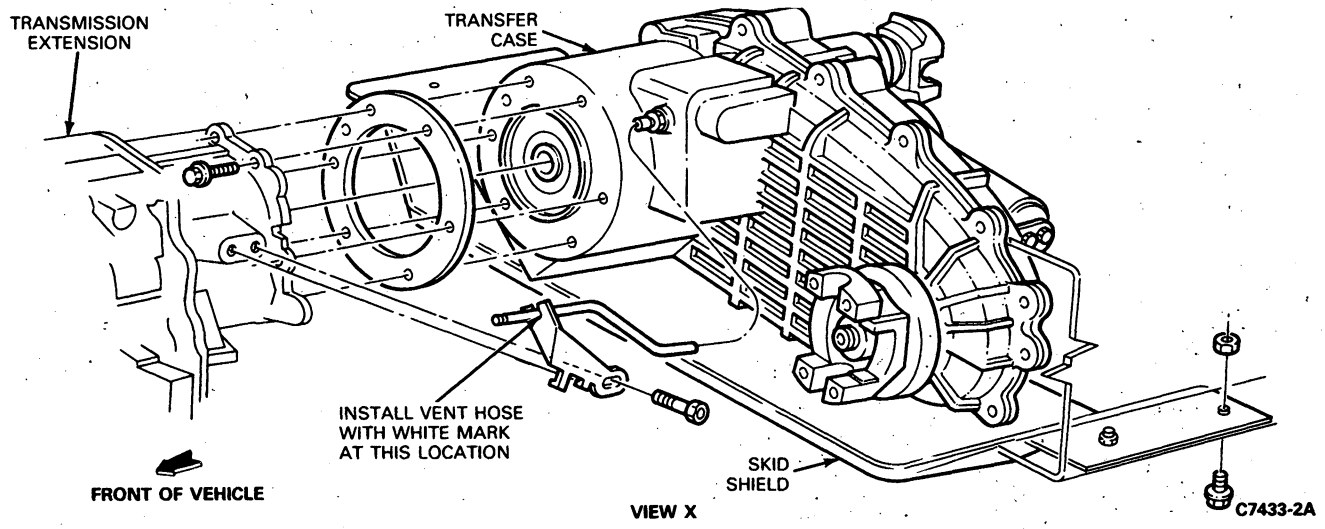
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REMOVAL AND INSTALLATION (Continued)

7. Disconnect the speedometer driven gear from the transfer case rear cover.
8. Disconnect the vent hose from the mounting bracket.

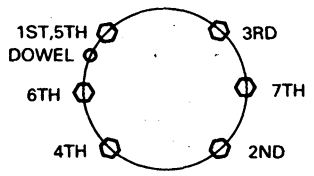
CAUTION: The catalytic converter is located beside the transfer case. Be careful when working around the catalytic converter because of the extreme high temperatures generated by the converter.

9. Support the transfer case with a suitable transmission jack Rotunda Number 077-00019 or equivalent.
10. Remove the six bolts retaining the transfer case to the transmission and the extension housing.
11. Slide the transfer case rearward off the transmission output shaft and lower the transfer case from the vehicle. Remove the gasket from the transfer case and transmission housing.



Installation

1. Place a new gasket between the transfer case and the transmission extension.
2. Raise the transfer case with the transmission jack so that the transmission output shaft aligns with the splined transfer case input shaft. Slide the transfer case forward onto the transmission output shaft and onto the dowel pin. Install the six transfer case retaining bolts to the extension housing. Tighten the bolts to 34-58 N·m (25-43 ft-lb) in the sequence shown.



TIGHTEN CASE TO EXTENSION BOLTS IN THIS SEQUENCE

C7434-1A

3. Remove the transmission jack from the transfer case.
4. Install the vent hose so that the white marking on the hose aligns with the notch in the mounting bracket.
5. Connect the speedometer driven gear to the transfer case rear cover. Tighten the screw to 2.3-2.8 N·m (20-25 in-lb).
6. Connect the rear driveshaft to the transfer case output shaft yoke. Tighten the bolts to 28-33 N·m (20-28 ft-lb).
7. Connect the front driveshaft to the transfer case front output shaft yoke. Tighten the nuts to 11-20 N·m (8-15 ft-lb).
8. Connect the wire connectors on the rear of the transfer case, making sure that the retaining tabs lock.
9. Install the drain plug and tighten to 19-30 N·m (14-22 ft-lb). Remove the fill plug and install 1.9 Liters (2.0 U.S. Quarts) of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent to the bottom of the fill hole. Install fill plug and tighten to 19-30 N·m (14-22 ft-lb).
10. Install the skid plate, bolts and nuts to the frame and tighten to 20-27 N·m (15-20 ft-lb).
11. Lower the vehicle.

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REMOVAL AND INSTALLATION (Continued)

Rear Or Front Output Shaft Oil Seals

Removal

1. Raise the vehicle on a hoist.
2. Remove the rear or front driveshaft from the transfer case output shaft yokes. Wire the driveshaft(s) out of the way.
3. Remove the output shaft yoke by removing the 30mm locknut, steel washer and rubber seal from the rear or front output shaft and remove the yokes.
4. Remove the oil seal from the rear output housing bore with Seal Remover, Tool T74P-77248-A and Impact Slide Hammer, T50T-100-A.
5. Remove the oil seal slinger from each yoke.

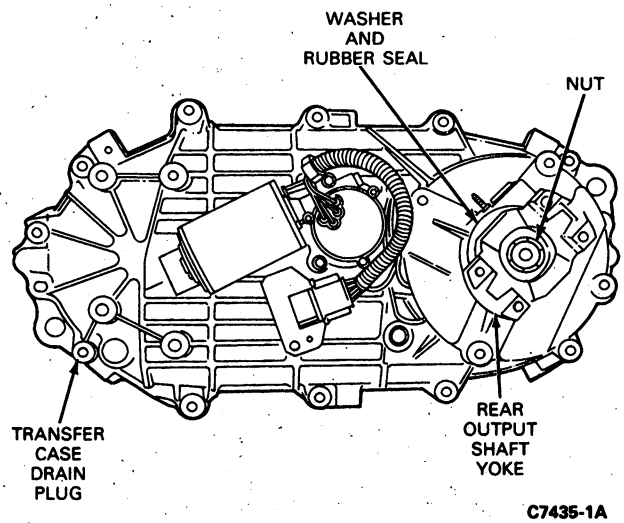
Installation

1. Make sure the front or rear output shaft output housing bores and faces are free from nicks and burrs. Coat the oil seals with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C175-B) or automatic transmission fluid. Position the oil seal into the front or rear output housing bore, making sure that the oil seal is not cocked in the bore. Drive the oil seal into the bore with Output Shaft Seal Installer, T83T-7065-B and Drive Handle, T80T-4000-W.
2. Install new seal slinger on each yoke. Do not scratch seal surface on yokes.
3. Install the yoke, rubber seal, steel washer and locknut on the front or rear output shaft. Tighten the locknut to 203-244 N·m (150-180 ft-lb).
4. Connect the front or rear driveshaft to the transfer case output shaft yokes. Tighten the bolts to 83-118 N·m (61-87 ft-lb).
5. Lower the vehicle from the hoist.

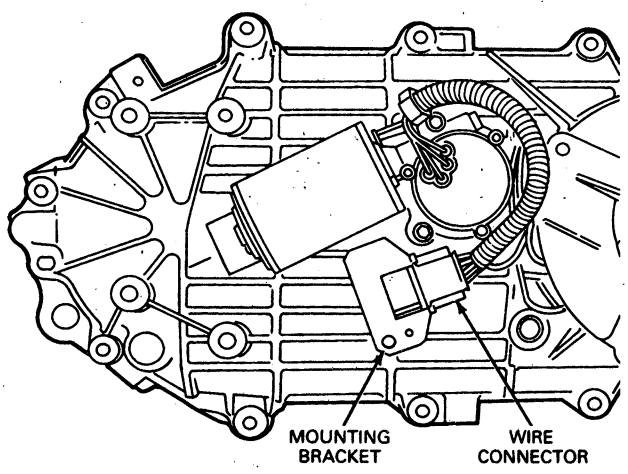
DISASSEMBLY AND ASSEMBLY

Disassembly

1. Remove the transfer case from the vehicle as described in the Removal and Installation portion of this Section.
2. Remove the transfer case drain plug with a 3/8 inch drive ratchet and drain the fluid.
3. Remove the front and rear output shaft yokes by removing the 30mm locknut, flat steel washer and rubber seal from the output shaft.
4. Remove the rear output shaft seal using Tool T74P-77248-A and T50T-100-A.



5. Remove the wire connector assembly from the mounting bracket on the rear cover. If required, remove the two bolts and remove the bracket.

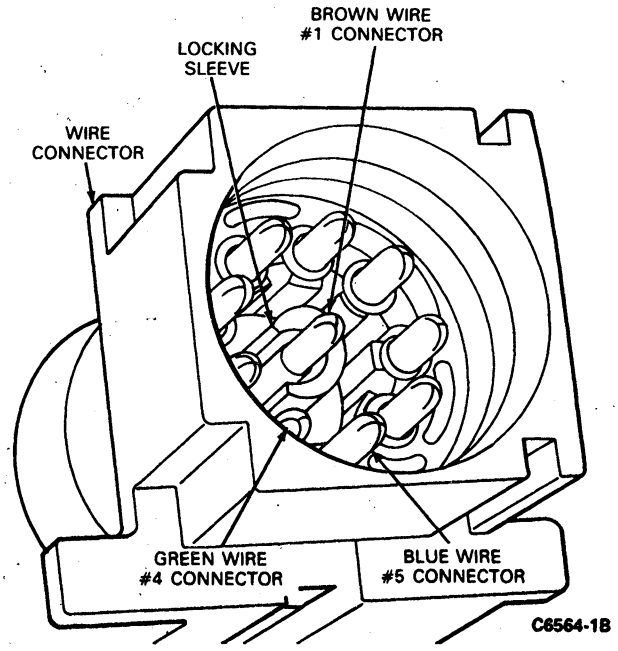


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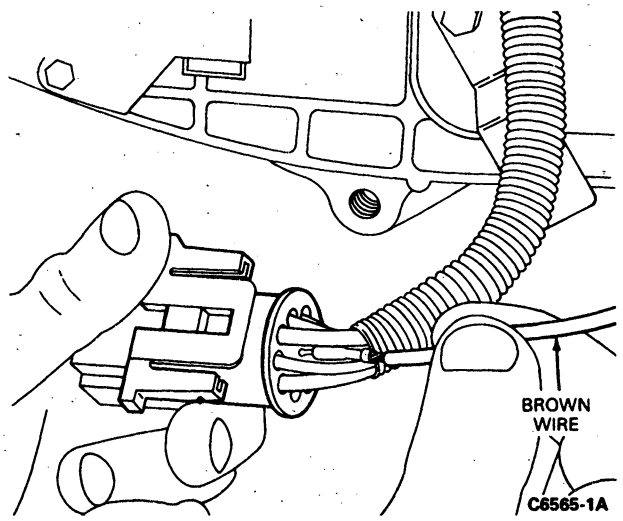
DISASSEMBLY AND ASSEMBLY (Continued)

6. Form a small hook at the end of a paper clip or safety pin. Remove the locking sleeve from the wire connector by hooking it with the paper clip or safety pin and pulling it up from the bottom.

CAUTION: Do not damage the wire connector locking sleeve.



7. Remove the brown wire from the No. 1 center position in the connector. If required, remove the speed sensor green wire from the No. 4 connector position and the blue wire from the No. 5 connector position.

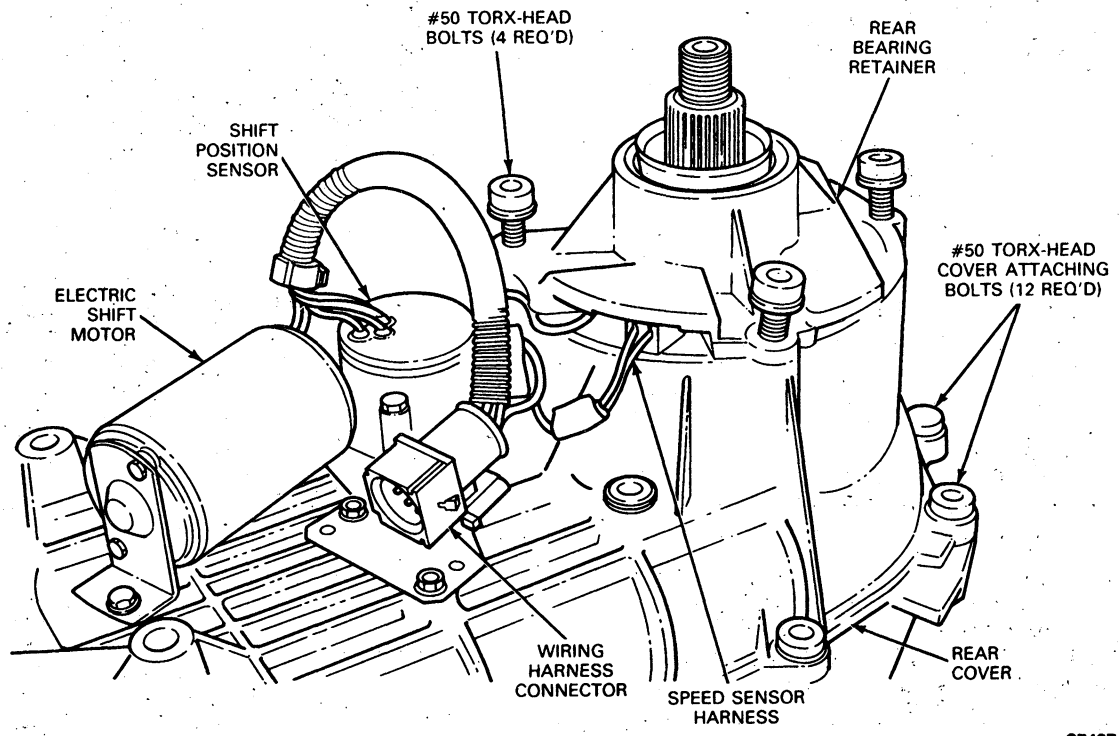


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DISASSEMBLY AND ASSEMBLY (Continued)

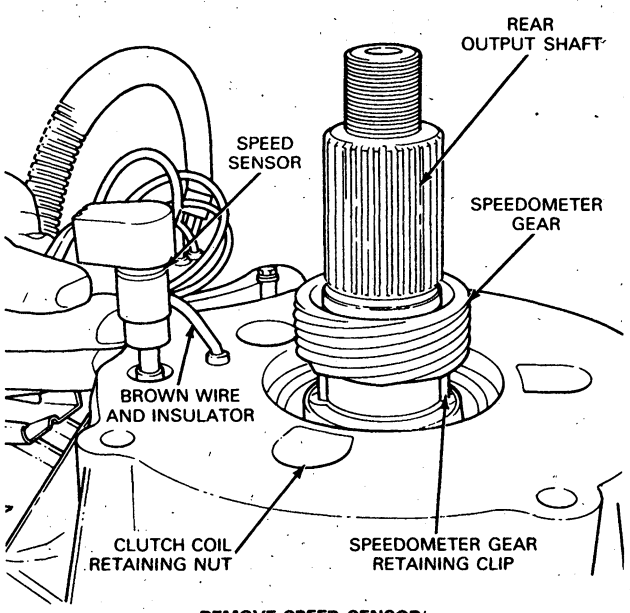
8. Remove the 4 No. 50 Torx® head bolts securing the rear bearing retainer to the cover. Pry the rear bearing retainer from the cover using a 1/2 inch drive breaker bar between the pry bosses and separate the bearing retainer from the cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the cover and the bearing retainer.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium cases.



REMOVE REAR BEARING RETAINER C7437-2A

9. Lift the rear output shaft and remove the speedometer gear retaining clip using a screwdriver.
10. Slide the speedometer gear forward and remove the ball with a small magnet. The speedometer gear can now be removed off of the rear of the output shaft.
11. Remove the speed sensor from the rear cover.



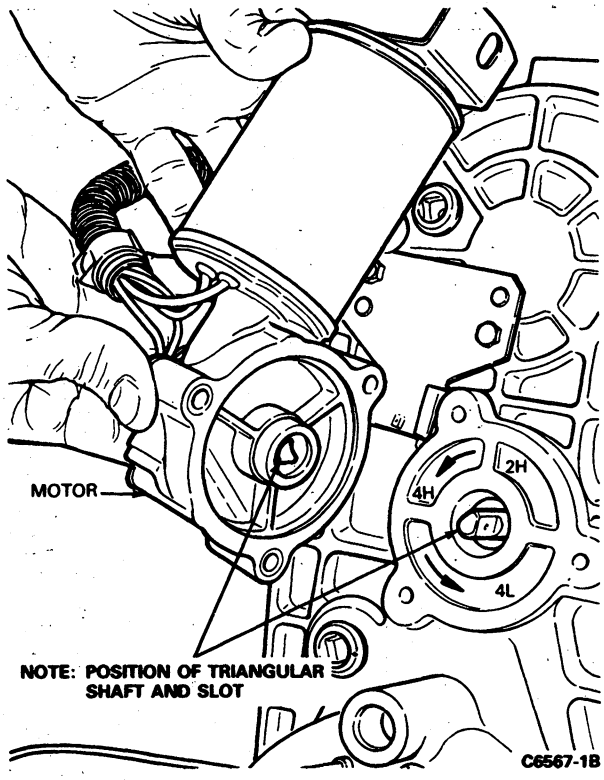
REMOVE SPEED SENSOR/ SPEEDOMETER GEAR C7438-1A

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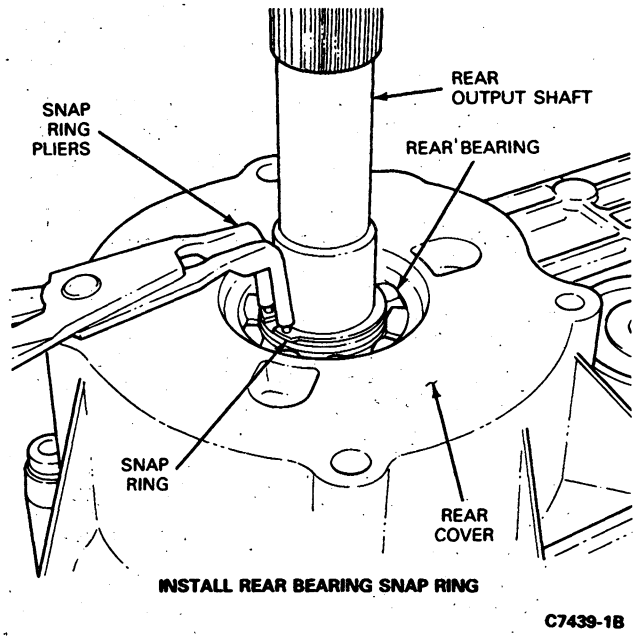
DISASSEMBLY AND ASSEMBLY (Continued)

12. Remove the four bolts attaching the shift motor to the rear cover and remove the shift motor. Note the position of the triangular shaft extending out of the rear cover and the triangular slot in the motor. Do not discard the washer under the motor support bracket, if present.

CAUTION: The motor is serviced as a complete assembly. Do not remove the screws that secure the rear cover to the motor gear housing.



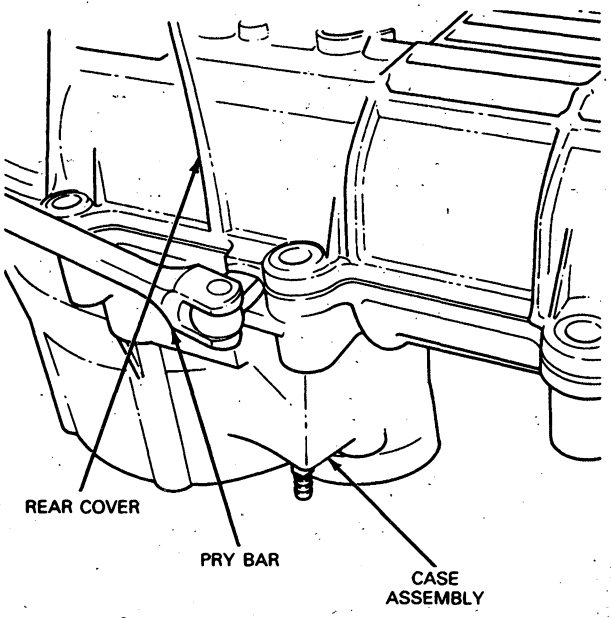
13. Remove the snap ring on the output shaft retaining the upper rear ball bearing using appropriate snap ring pliers.



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DISASSEMBLY AND ASSEMBLY (Continued)

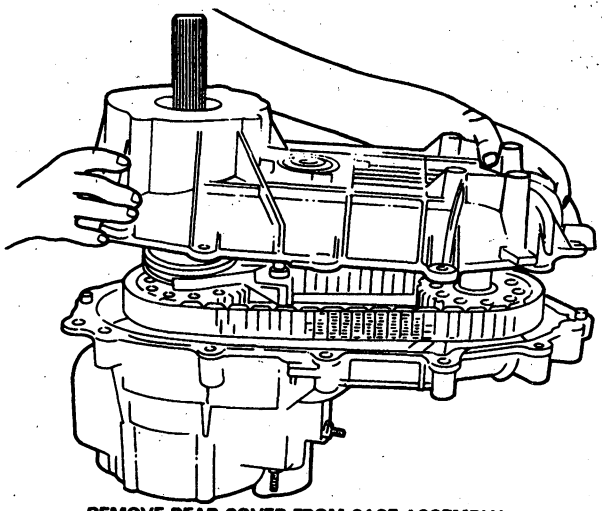
14. Remove the 12 No. 50 Torx® head bolts that retain the front case of the rear cover. Insert a 1/2 inch drive breaker bar between the pry bosses and separate the front case from the rear cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the front case and the rear cover.



REMOVE REAR COVER FROM CASE

C7440-1B

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium housings.

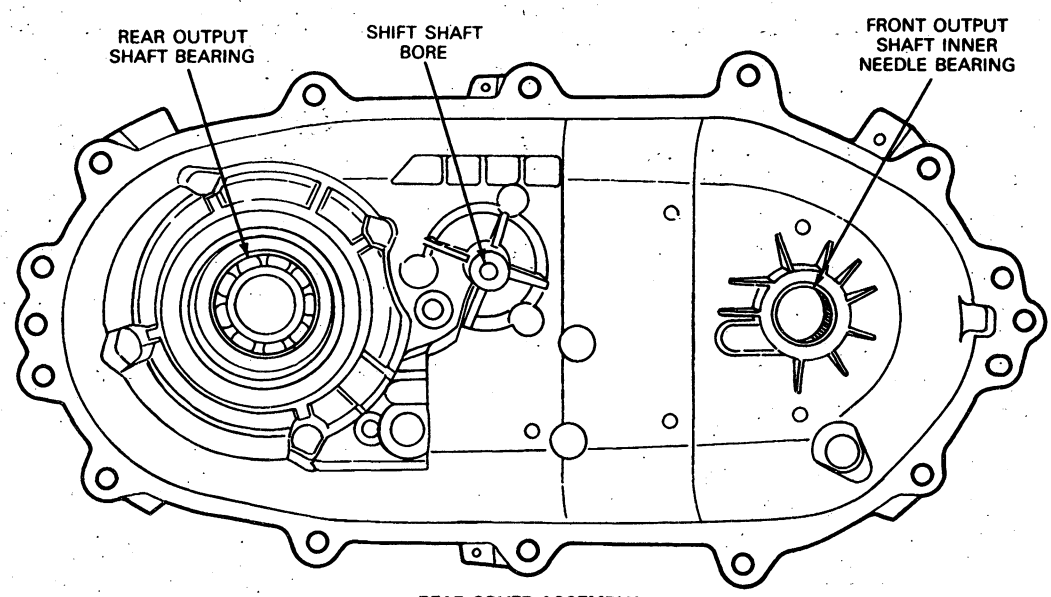


REMOVE REAR COVER FROM CASE ASSEMBLY

C7441-1A

15. Remove the front output shaft caged needle bearing from the rear cover with puller Tool D80L-100-T and impact slide hammer Tool T50T-100-A.

16. Remove the rear output shaft bearing from the inside of the case using a suitable tool.



REAR COVER ASSEMBLY

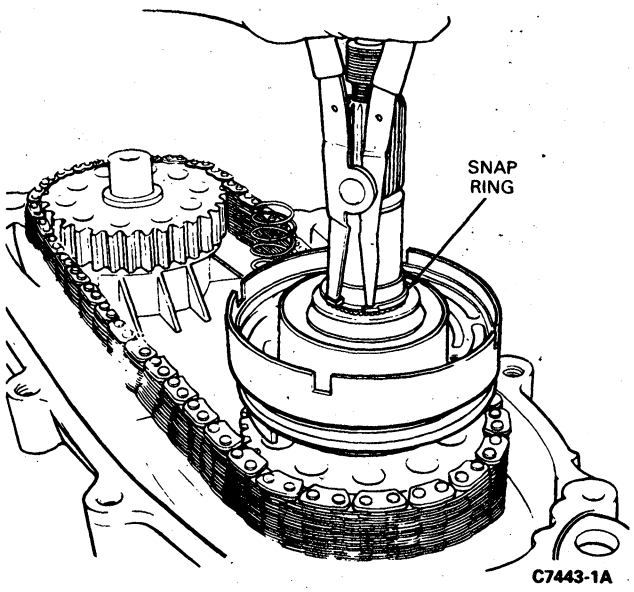
C7442-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

17. Remove the nuts retaining the clutch coil assembly to the rear cover. Pull the assembly along with the O-rings and brown wire, from the cover.
18. Remove the shift shaft bushing and seal from the rear cover using appropriate tools.
19. Remove the snap ring on the output shaft securing the clutch housing. Slide the clutch housing and the 4WD hub off of the output shaft.

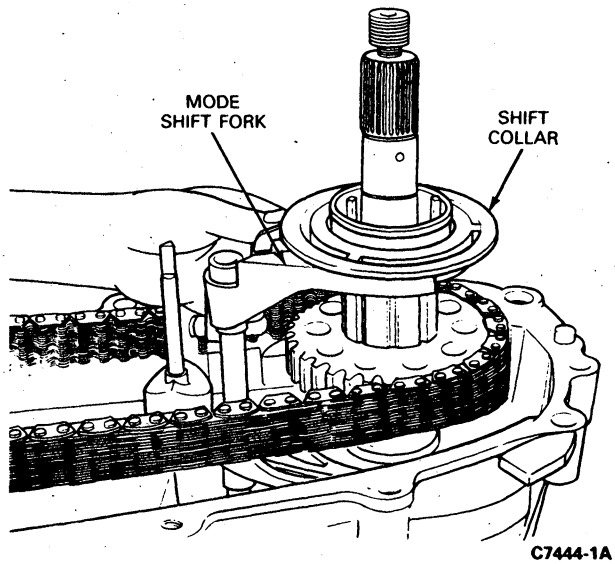
REMOVE CLUTCH HOUSING RETAINING SNAP RING



C7443-1A

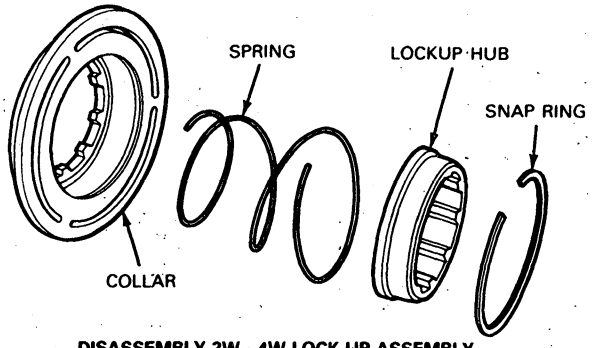
20. Remove the spring from the shift shaft and lift the mode shift fork complete with the shifting collar from the upper rear output shaft sprocket splines.

REMOVE MODE SHIFT FORK AND SHIFT COLLAR



C7444-1A

21. Disassemble the 2W-4W lockup assembly by removing the internal snap ring and pull the lockup hub and spring from the collar.



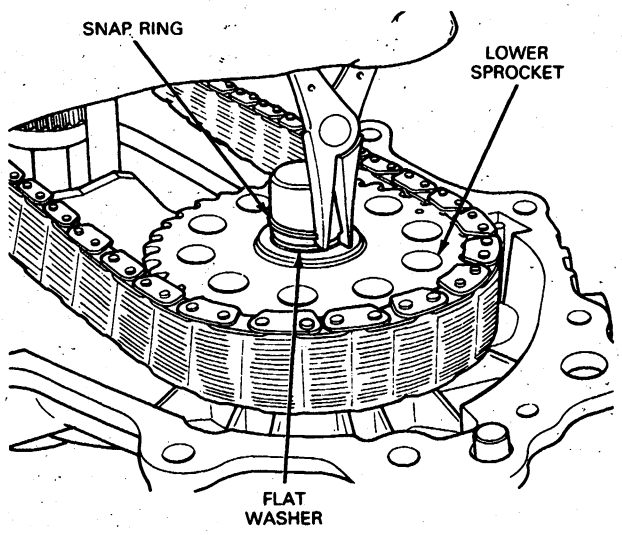
DISASSEMBLY 2W - 4W LOCK-UP ASSEMBLY

C7445-1A

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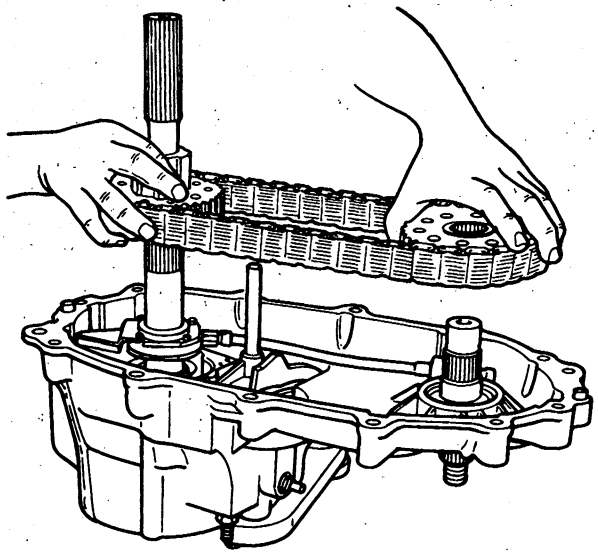
DISASSEMBLY AND ASSEMBLY (Continued)

22. Remove the snap ring retaining the lower sprocket to the lower output shaft. Grasp the upper and lower sprocket complete with the chain and lift them at the same time from the upper and lower output shafts.



REMOVE SNAP RING - LOWER SPROCKET

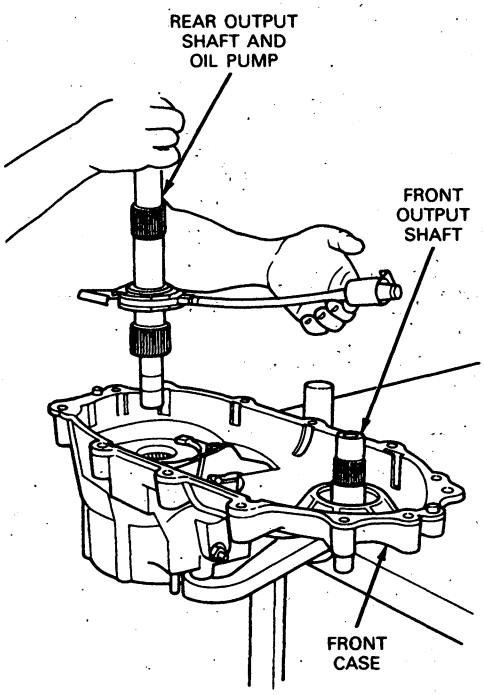
C7446-1A



CHAIN REMOVAL

C7447-1A

23. Remove the shift rail by sliding it straight out from the shift fork.
24. Remove the chip collecting magnet from its slot in the case.
25. Lift out the pump screen and remove the output shaft assembly with the pump assembled on it. If the pump is to be disassembled, remove the four bolts from the pump body. Note the position of the pump front body, pins, spring, rear cover and pump retainer as removed.



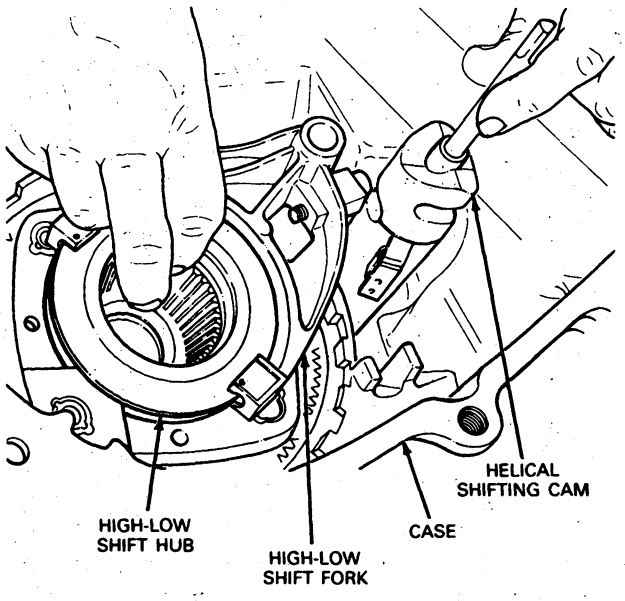
INSTALLATION - REAR OUTPUT SHAFT AND OIL PUMP

C7450-1A

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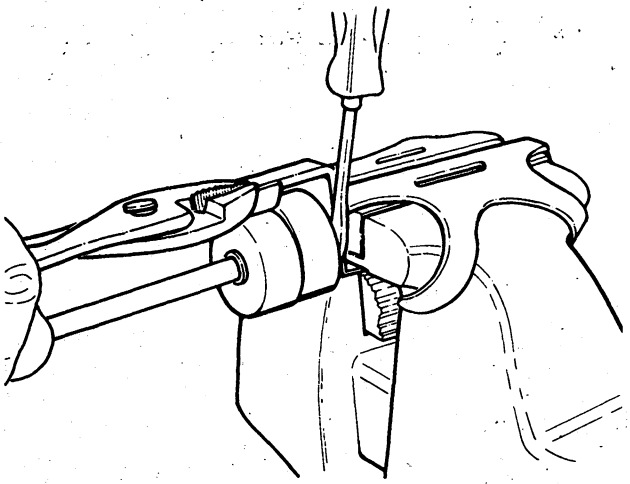
DISASSEMBLY AND ASSEMBLY (Continued)

26. Remove the high low shift fork by first rotating it until the roller is free from the cam then sliding out of engagement from the shifting hub.



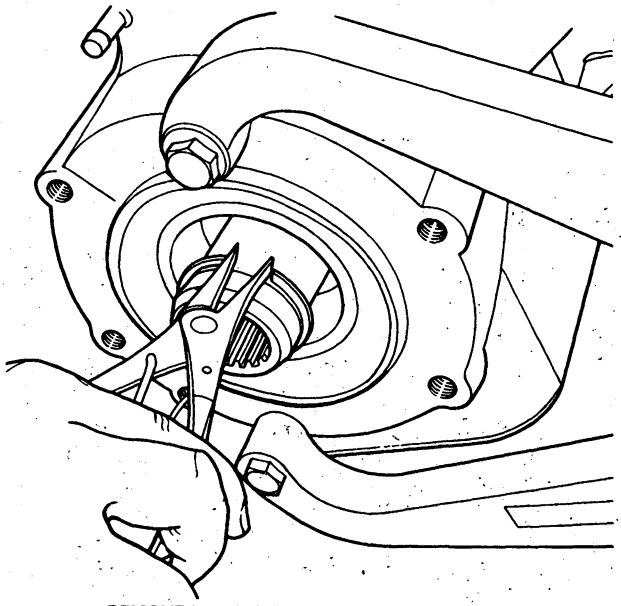
REMOVE HIGH-LOW SHIFT FORK C7448-1A

27. Remove the helical cam assembly from the front case. If it is necessary to disassemble the helical cam assembly care should be exercised as the cam is slid rearward to disengage it from the spring. The spring is energized and can release violently. The spring must be removed from the helical cam and the shaft finger. Do not get your fingers in the way when disengaging the spring. It will rotate to the point that the spring ends will be roughly 180 degrees apart.



DISASSEMBLY OF HELICAL CAM ASSEMBLY C7449-1A

28. Remove the high low shift hub.
29. Remove the front output shaft from the front case.
30. Turn the front case over and remove the front oil seal out of the case using Tool T74P-77248-A and T50T-100-A.
31. Reaching through the front opening of the case with a pair of snap ring pliers, expand the snap ring on the input shaft and carrier assembly allowing it to drop out of the bearing. The carrier assembly, including the input shaft is serviced as an assembly only. If the needle bearing or bushing is to be replaced in the input shaft, drive out both of them through the input shaft splines using appropriate tools.

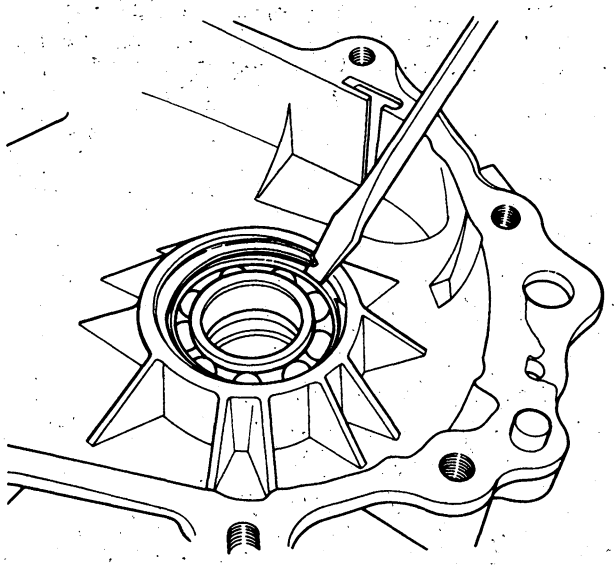


REMOVE INPUT SHAFT BEARING SNAP RING C7851-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

32. Remove the ring gear by prying out the internal snap ring and lifting out the gear.
33. Remove the front input shaft bearing by removing the internal snap ring securing the bearing to the case and drive it out from the outside of the case using Tool T73T-1202-B and T80T-4000-W.
34. Remove the front output shaft bearing from case by removing the internal snap ring retaining the output shaft bearing in the case and drive the bearing out of the case from the front of the case using Tool T73T-1202-B and T80T-4000-W.



REMOVE FRONT OUTPUT SHAFT BEARING RETAINING SNAP RING

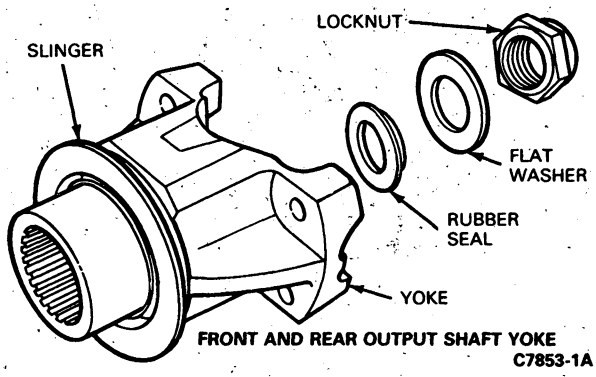
C7852-1A

Assembly

NOTE: Before assembly, lubricate all parts with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent.

Clean all chips out of the case attaching bolt holes.

1. Install the input shaft bearing and the front output shaft bearing into the case using Tool T80T-4000-P and Tool T80T-4000-W. Install the appropriate internal snap rings retaining the bearings in the case.
2. Install the front output shaft seal into the case until it is fully seated against the case using Tool T86T-7034-CA.
3. Install the front output shaft through the lower bearing of the case. The front output shaft is retained in the case by the front yoke assembly. Install the front yoke assembly onto the output shaft, the rubber seal, the flat washer, and the locknut. Tighten locknut to 203-244 N·m (150-180 ft-lbs).



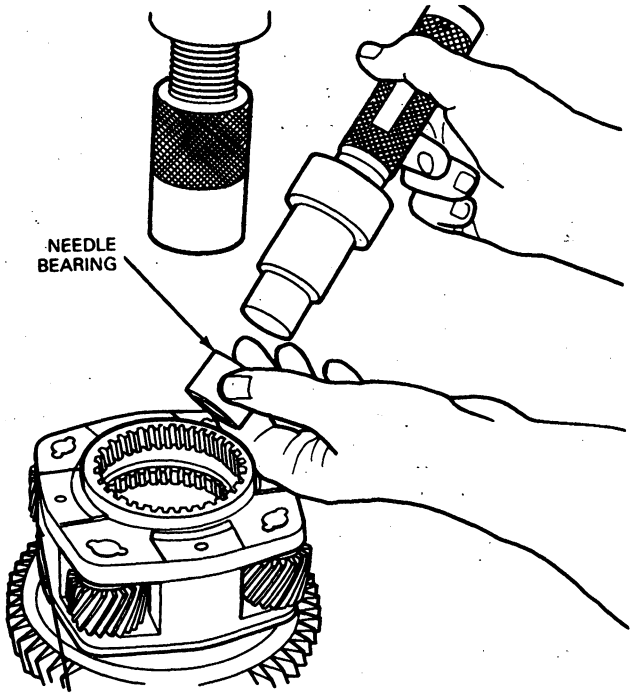
FRONT AND REAR OUTPUT SHAFT YOKE

C7853-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

4. Press the needle bearing and bronze bushing into the input shaft with the appropriate tools.



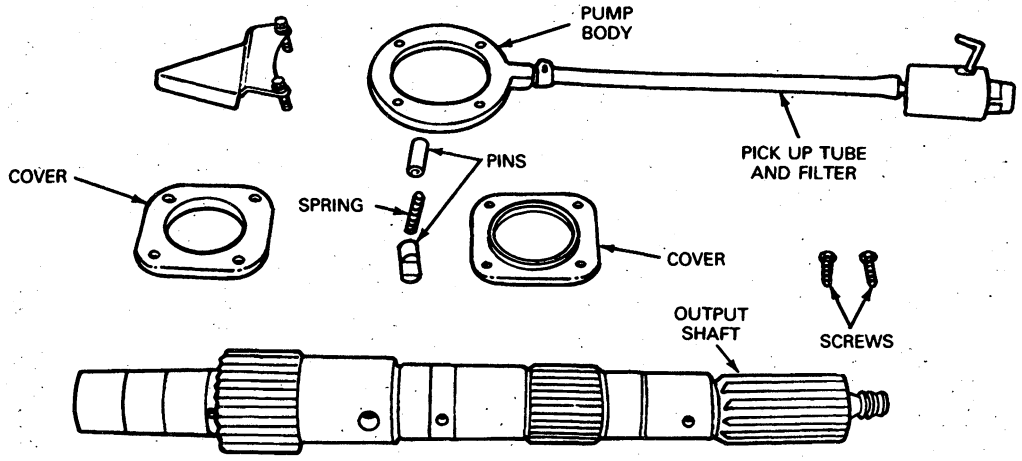
INSTALL INPUT SHAFT NEEDLE BEARING C7854-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

5. Install the ring gear into the slots in the case and retain it with the large internal snap ring making sure that it is fully seated.
6. Insert the input shaft and carrier assembly in the case through the input shaft bearing being careful not to damage the gear teeth when aligning them with the ring gear teeth.
7. While supporting the input shaft and carrier assembly in the case, install a new snap ring on the front side of the bearing making sure that it is fully seated in the snap ring groove of the input shaft.
8. Install the upper input shaft oil seal into the case using an appropriate tool until it is fully seated against the case.
9. Reassemble the helical cam assembly by engaging one end of the spring on the shaft finger and the other end of the spring on the cam finger. With the shaft finger secured carefully in a soft jawed vice, turn the cam to wind up the spring until the fingers of the cam and the shaft are in alignment and slide the cam forward to lock the spring in the cocked position.
10. Install the cam assembly in the small hole of the case with the shaft vertical.
11. Reassemble the pump and output shaft as follows: Place the oil pump cover with the word TOP facing the front of the front case. Install the two pins (with the flats facing upwards) with the spring between the pins and place the assembly in the oil pump bore in the output shaft. Place the oil pump body and pick up tube over the shaft and make sure that the pins are riding against the inside of the pump body. Place the oil pump rear cover with the words TOP REAR facing the rear of the case. The word TOP on the front cover and the rear cover should be on the same side. Install the pump retainer with the tabs facing the front of the transfer case. Install the four retaining bolts and rotate the output shaft while tightening the bolts to prevent the pump from binding. Tighten the bolts to 4.-4.5 N·m (36-40 in-lb). Lubricate the assembly with some automatic transmission fluid.

NOTE: The output shaft must turn freely within the oil pump. If binding occurs, loosen the four bolts and retighten again.

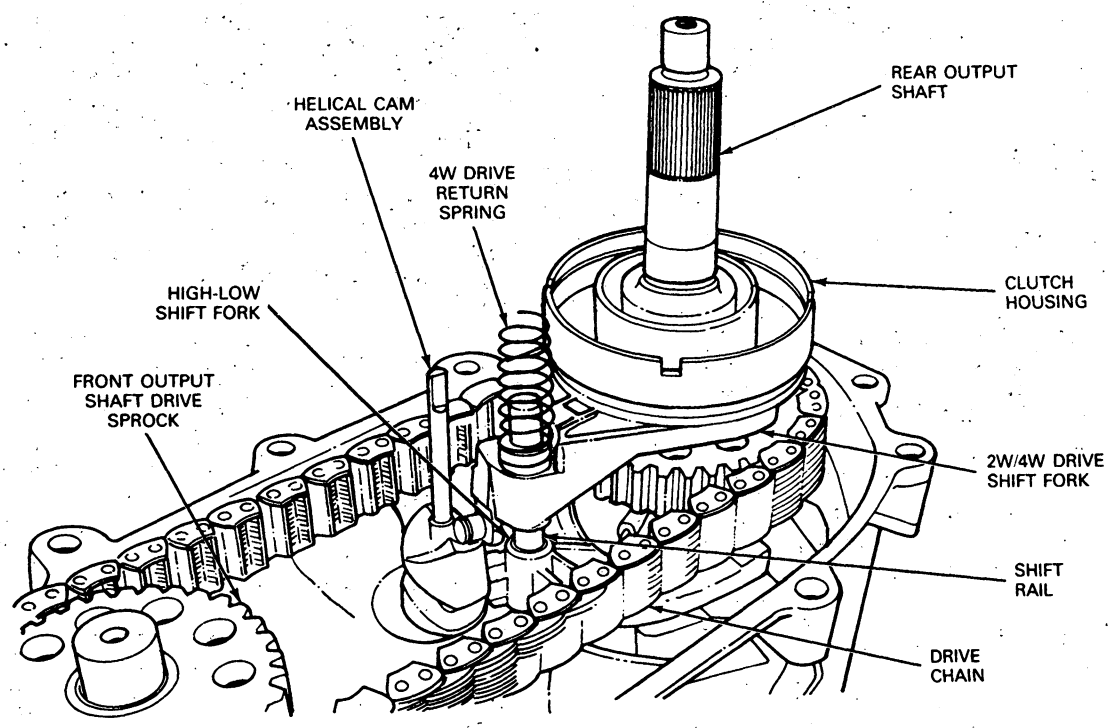


REAR OUTPUT SHAFT AND OIL PUMP ASSEMBLY - EXPLODED VIEW C7855-2B

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DISASSEMBLY AND ASSEMBLY (Continued)

12. Install the high low shift hub.
13. Install the high low shift fork by engaging it with the shift hub flange and rotating it until the roller is engaged with the lower groove of the helical cam.
14. Install the shift rail through the high low fork bore and into the rail bore in the case.
15. Install the output shaft and oil pump assembly in the input shaft. Make sure that the external splines of the output shaft engage the internal splines of the high low shift hub. Make sure that the oil pump retainer and oil filter leg are in the groove and notch of the front case. Install the collector magnet in the notch in the front case.
16. Assemble the upper and lower sprockets with the chain and place them as an assembly over the upper and lower output shafts. Install the washer and the snap ring which retain the lower sprocket in position.
17. Assemble the 2W-4W lockup assembly by installing the tapered compression spring in the lockup collar with the small end installed first. Place the lockup hub over the spring and compress the spring while installing the internal snap ring which holds the lockup assembly together.
18. Install the lockup assembly and its shift fork over the external splines of the upper sprocket and the shift rail with the clutch face facing rearward and the long boss of the shift rail facing forward.
19. Assemble the 4WD return spring over the shift rail and against the shift fork.
20. Place the 4WD hub over the external splines of the output shaft.
21. Place the clutch housing over the splines of the output shaft and secure with the appropriate snap ring. Make sure that the snap ring is fully seated in the snap ring groove.



INSTALLATION SHIFT MECHANISM

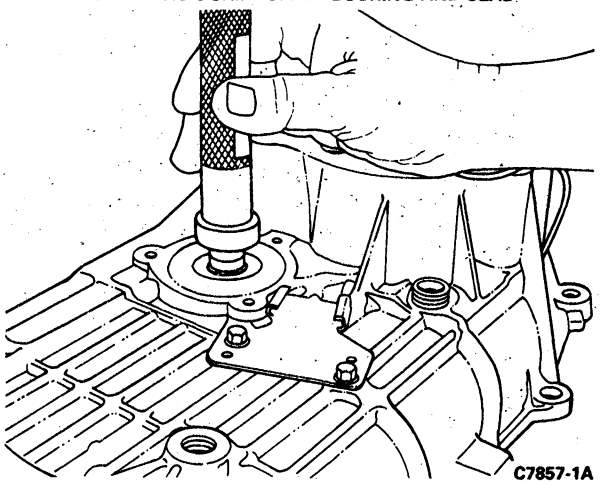
C7856-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

22. Press the front output shaft inner needle bearing in the bore in the cover using appropriate tools.
23. Press the rear output shaft bearing into the bore in the cover using appropriate tools.
24. Install a new shift shaft bushing and oil seal into the cover using appropriate tools.

INSTALLATION SHIFT SHAFT BUSHING AND SEAL



25. Install new O-rings (if the old rings are cracked or broken) on the clutch coil assembly studs and grommet. Install the clutch coil assembly from the inside the rear cover until the wire and studs extend through the cover. Install the three nuts and tighten to 8.1-10.8 N·m (6-8 lb-ft).

CAUTION: Do not kink or trap the wire while seating the clutch coil assembly to the cover.

26. Install the rear output shaft oil seal in the bearing retainer using the appropriate tool making sure that it is fully seated.
27. Coat the mating surface of the front case with a bead of non-acid cure Silicone Rubber, E7TZ-19562-A (ESL-M4G273-A).
28. Place the cover on the case making sure that the lower output shaft, shift shaft and shift rail are aligned. Install and tighten the 12 No. 50-Torx® head case to cover bolts to 22-36 lb-ft.
29. Install the rear bearing snap ring on the output shaft making sure that the snap ring is fully seated in the groove of the shaft.
30. Place the speedometer drive gear over the shaft with the slot aligned with the hole for the drive ball. The gear should go completely against the snap ring which retains the output shaft. Place the ball in the hole and pull the speedometer gear over the ball. Snap the retaining clip between the snap ring and the speedometer gear.
31. Install the speed sensor in its bore of the cover.
32. Apply a bead of non acid cure Silicone Rubber, E7TZ-19562-A (ESL-M4G273-A), to the face of the rear bearing retainer.
33. Place the rear bearing retainer onto the rear cover and secure with the 4 Torx® head bolts tightened to 22-36 lb-ft.

CAUTION: Do not trap the brown wire beneath the bearing retainer.

34. Install the rear output shaft yoke assembly onto the rear splines of the output shaft. Install the rubber seal, flat washer and 30mm locknut on the output shaft and tighten to 203-244 N·m (150-180 lb-ft).
35. Using pliers equipped with soft jaws, rotate the triangular shift shaft so it is aligned with the triangular slot in the motor.
36. Slightly loosen the two nuts that attach the slotted support bracket to the end of motor house.

Note: Do not loosen the two nuts or studs that attach the motor end cap to motor housing.

37. Apply black non-acid cure silicone rubber E7TZ-19562-A (ESL-M4G73-A) to motor housing base and install on transfer case.
38. Install three N800670-S screws along with speed sensor 7K470 bracket and tighten to 8.1-10.8 N·m (6-8 lb-ft.)
39. Holding the slotted support bracket tight against the motor housing end, secure the bracket to the transfer case, turning the N802503-S with N801723-S12 lock washer to 8.1-10.8 N·m (6-8 lb-ft.).
40. Retighten the two nuts that attach the slotted support bracket to the end of motor to 2.7-3.4 N·m (2-2.5 lb-ft.)

NOTE: If the shaft will not stay in the 4H position, rotate the shaft clockwise to the 2H position. Install the motor and rotate counterclockwise until the motor is aligned with the mounting holes.

41. Install the brown clutch coil wire to the No. 1 center terminal, and, if removed, the speed sensor green wire to the No. 4 connector position and the blue wire to the No. 5 connector position. Install the locking sleeve.
42. Install the wire connector mounting bracket on the rear cover. Install the bolts and tighten to 8-11 N·m (6-8 lb-ft).
43. Install the wire connector to the mounting bracket.
44. Install the drain plug and tighten to 19-30 N·m (14-22 lb-ft).
45. Place a 3/8 inch drive ratchet in the fill plug and remove the plug. Fill the transfer case with 1.9 Liters (2.0 U.S. Quarts) of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or DDX (ESP-M2C166-H) or equivalent.
46. Install the fill plug and tighten to 19-30 N·m (14-22 lb-ft).
47. Install the transfer case as described in the Removal and Installation portion of this Section.

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 lb.	Universal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-T	Collet	Universal 1-1/4" to 1-1/2"
D80L-100-H	Actuator Pin	Use with Blind Hole Puller
TOOL-1175-AC	Seal Remover	Universal — Use with Impact Slide Hammer
T80T-7127-B	Output Bearing Replacer — Front	Borg Warner #1356 Transfer Case
T80T-7127-C	Output Bearing Replacer — Rear	Borg Warner #1356 Transfer Case
T80T-4000-P	Bearing Installer	Borg Warner #1356 Transfer Case
T74P-77248-A	Oil Seal Remover	Borger Warner #1356 Transfer Case
T61L-7657-B	Oil Seal Installer	Borg Warner #1356 Transfer Case
T85T-7034-AH	Extension Housing Bushing Remover	Borg Warner #1356 Transfer Case
T85T-7034-BH	Extension Housing Bushing Installer	Borg Warner #1356 Transfer Case
T80T-4000-W	Driver Handle	Borg Warner #1356 Transfer Case
T86T-7034-CH	Oil Seal Installer	Borg Warner #1356 Transfer Case
T73T-1202-B	Bearing Insatller	Borg Warner #1356 Transfer Case
T73T-1202-A	Bearing Installer	Borg Warner #1356 Transfer Case
T83T-7065-B	Output Shaft Seal Installer	Borg Warner #1356 Transfer Case

CC7858-2B

TORQUE SPECIFICATIONS

Description	Torque Limits	
	N-m	Ft-Lbs
Case Half Attaching Bolts	48-54	35-40
Four Wheel Drive Indicator Switch	11-16	8-12
Front and Rear Output Yokes to Transfer Case	163-203	120-150
Drain Plug	19-30	14-22
Fill Plug	19-30	14-22
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke	11-20	8-15
Rear Driveshaft to Rear Output Yoke — Bolt — Bronco	28-33	20-28
Rear Driveshaft to Rear Output Yoke — Nut — F150-F350 4x4	11-20	8-15

CC7859-2C

ROTUNDA EQUIPMENT

Number	Description
077-00019	Transmission Jack
071-00002	Gasket Compound
007-00001	Digital Volt-Ohm Meter

CC9466-1A

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SECTION 16-81 Borg-Warner 13-56 Transfer Case—Manual Shift

SUBJECT	PAGE
ADJUSTMENTS	
Fluid Level Check	16-81-2
DESCRIPTION	16-81-1
DIAGNOSIS AND TESTING	16-81-2
DISASSEMBLY AND ASSEMBLY	
Transfer Case	16-81-6
REMOVAL AND INSTALLATION	
Rear Or Front Output Shaft With Fixed Yokes Oil Seal	16-81-6
REMOVAL AND INSTALLATION (Cont'd.)	
Shift Lever	16-81-4
Transfer Case	16-81-2
SPECIFICATIONS	16-81-21
VEHICLE APPLICATION	16-81-1

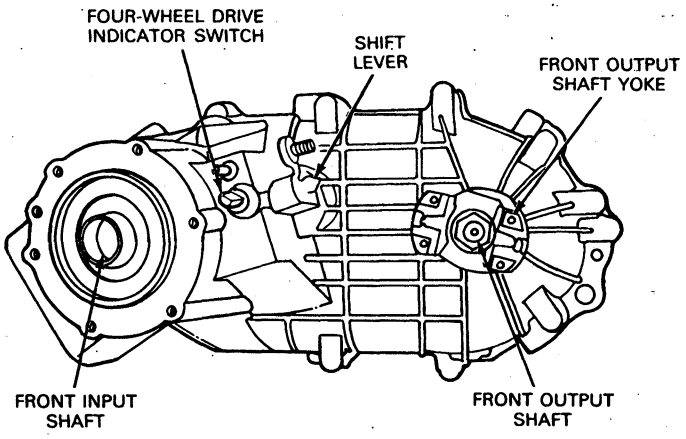
VEHICLE APPLICATION

F-150—F-350 (4x4), F-350 (4x4) with PTO and Bronco Vehicles.

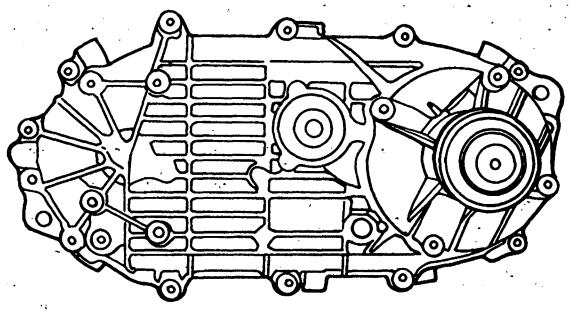
DESCRIPTION

The Borg-Warner 13-56 manual shift transfer case is a three piece transfer case. One of the case halves is aluminum and one of the case halves is magnesium. It is a part time case and is equipped for a power take off. The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle without disconnecting the rear driveshaft.

On the front case half, the front input shaft, front output shaft, four-wheel drive indicator switch, and shift lever are located. On the rear case half, the rear output shaft, output shaft bearing retainer, (or slip yoke-type bearing retainer), and drain and fill plugs are located. Two types of bearing retainers are used: a rear fixed output yoke and a slip yoke type.



FRONT VIEW



BORG-WARNER 13-56 - MANUAL SHIFT TRANSFER CASE - REAR

C7860-2A

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ADJUSTMENTS

Fluid Level Check

Remove the fill plug from the rear case. Fluid level should be just below the fill plug. If the fluid is below the level, fill with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent to correct level.

DIAGNOSIS AND TESTING

Refer to Section 16-10, General Manual Transmission Service, for diagnosis and testing procedures.

REMOVAL AND INSTALLATION

Transfer Case

Removal

1. Raise vehicle on a hoist.
2. Place a drain pan under transfer case, remove drain plug and drain fluid from transfer case.
3. Disconnect four wheel drive indicator switch wire connector at transfer case.
4. Disconnect front driveshaft from front output yoke.
5. Disconnect rear driveshaft from rear output shaft yoke.
6. Disconnect speedometer cable assembly from transfer case rear bearing retainer.
7. Disconnect vent hose (7D494) from transfer case.
8. Disconnect the shift rod (7A315) between the transfer case shift lever (7B106) and the control lever assembly (7E069).

CAUTION: Catalytic converter is located beside heat shield. Be careful when working around catalytic converter because of the extremely high temperatures generated by the converter.

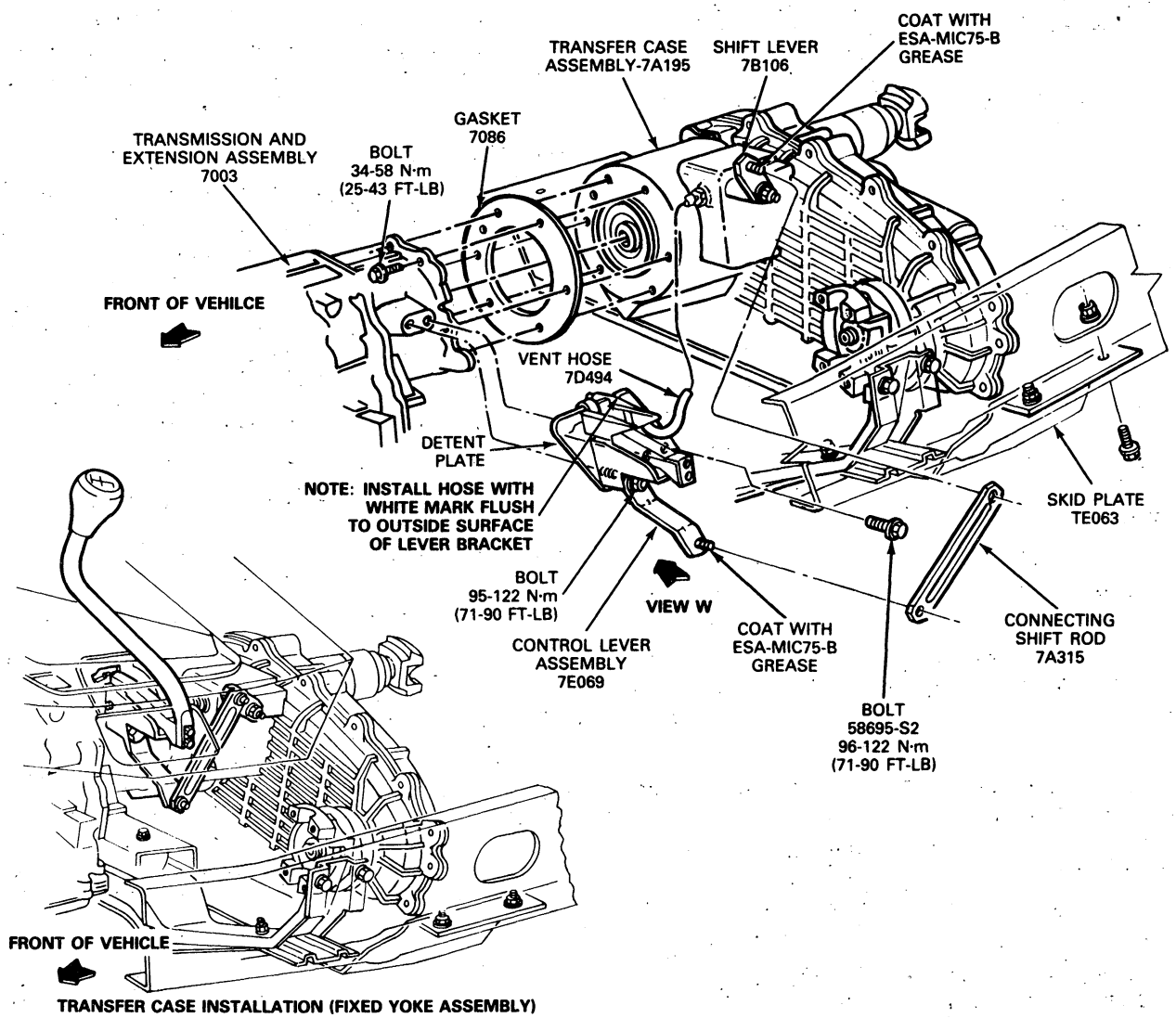
9. Support transfer case with a transmission jack Rotunda Number 077-00019 or equivalent.
10. Remove the bolts retaining transfer case to transmission adapter.
11. Slide transfer case rearward off of the transmission output shaft and lower transfer case from vehicle and remove gasket between transfer case and adapter.

Installation

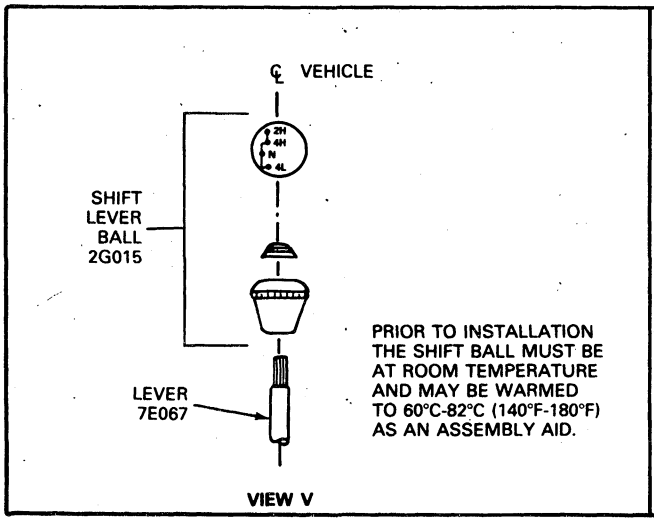
1. Place a new gasket between transfer case and adapter.
2. Raise transfer case with transmission jack so transmission output shaft aligns with splined transfer case input shaft. Slide transfer case forward on to transmission output shaft and onto the dowel pin. Install bolts retaining transfer case to adapter. Tighten bolts in the torque sequence shown in View V. Tighten the bolts to 34-58 N·m (25-43 ft-lb).
3. Remove transmission jack from transfer case.
4. Connect rear driveshaft to rear output shaft yoke. For Bronco, tighten bolts to 28-33 N·m (20-25 ft-lbs), for F150—F350 4x4, tighten nut to 11-20 N·m (8-15 ft-lbs).
5. Connect vent hose (7D494) to transfer case.
6. Attach the shift rod (7A315) between the transfer case shift lever (7B106) and the control lever assembly (7E069).
7. Connect speedometer cable assembly to transfer case.
8. Connect four wheel drive indicator switch wire connector at transfer case.
9. Connect front driveshaft to front output yoke. Tighten nut to 11-20 N·m (8-15 ft-lbs).
10. Install skid plate to frame. Tighten nuts and bolts to specification.
11. Install drain plug and tighten to 9-18 N·m (6-14 ft-lbs). Remove filler plug and install Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent to the bottom of the fill plug hole. Install filler plug and tighten to 21-33 N·m (15-25 ft-lbs).
12. Lower vehicle.

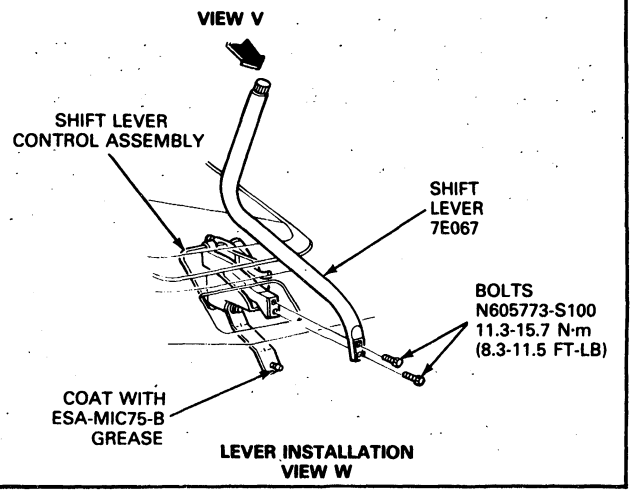
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REMOVAL AND INSTALLATION (Continued)



TRANSFER CASE INSTALLATION (FIXED YOKE ASSEMBLY)





C7861-2D

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REMOVAL AND INSTALLATION (Continued)

Shift Lever

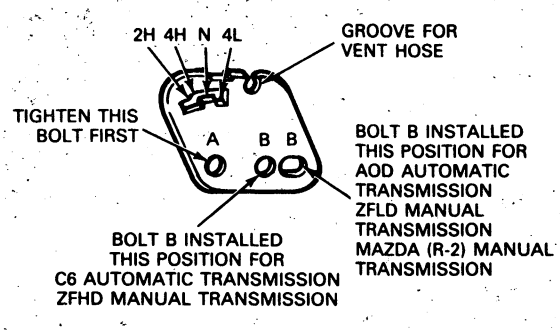
NOTE: Remove the shift ball only if the shift ball, boot or lever (7E067) is being replaced.

Removal

1. Remove shift ball.
2. Remove the two bolts (N605773) attaching the shift lever (7E067) to the control lever assembly (7E069).
3. Disconnect the vent hose (7D494) from the control lever assembly (7E069) detent plate.
4. Disconnect the shift rod (7A315) between the transfer case shift lever (7B106) and the control lever assembly (7E069).
5. Remove the two bolts retaining the control lever assembly (7E069) to the transmission extension housing.

Installation

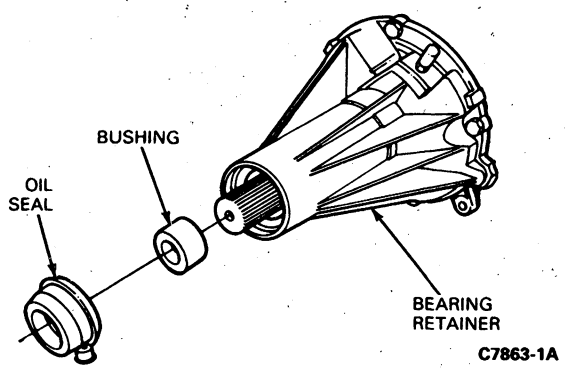
1. Prior to installing the shifter assembly make sure the transfer case shift lever (7B106) is in the "4L' position (all the way down and pointing towards the front of the vehicle).
2. Install the control lever assembly (7E069) with bolts "A' and "B' hand started. Make sure the lever assembly is in the "4L' position of the detent plate (rear most position of detent plate).
3. Hold the control lever assembly (7E069) in this position and tighten bolt "A' first to 95-122 N·m (71-90 ft-lb) as shown. Then tighten bolt "B' to 95-122 N·m (71-90 ft-lb).
4. Install the vent hose (7D494) so the white mark on the hose is in position with the notch in the detent plate.
5. Connect the shift rod (7A315) between the transfer case shift lever (7B106) and the control lever assembly (7E069).
6. Attach the shift lever (7E067) to the control lever assembly (7E069) and tighten bolts (N605773) to 11.3-15.7 N·m (8.3-11.5 ft-lb).
7. Install the shift boot and ball if previously removed.
8. Check the transfer case for proper shifting and operation.



DETENT PLATE
E4OD AUTOMATIC TRANSMISSION
T18 MANUAL TRANSMISSION

C9015-1B

Rear Output Shaft Bearing Retainer Oil Seal and Bushing—Slip Spline Type



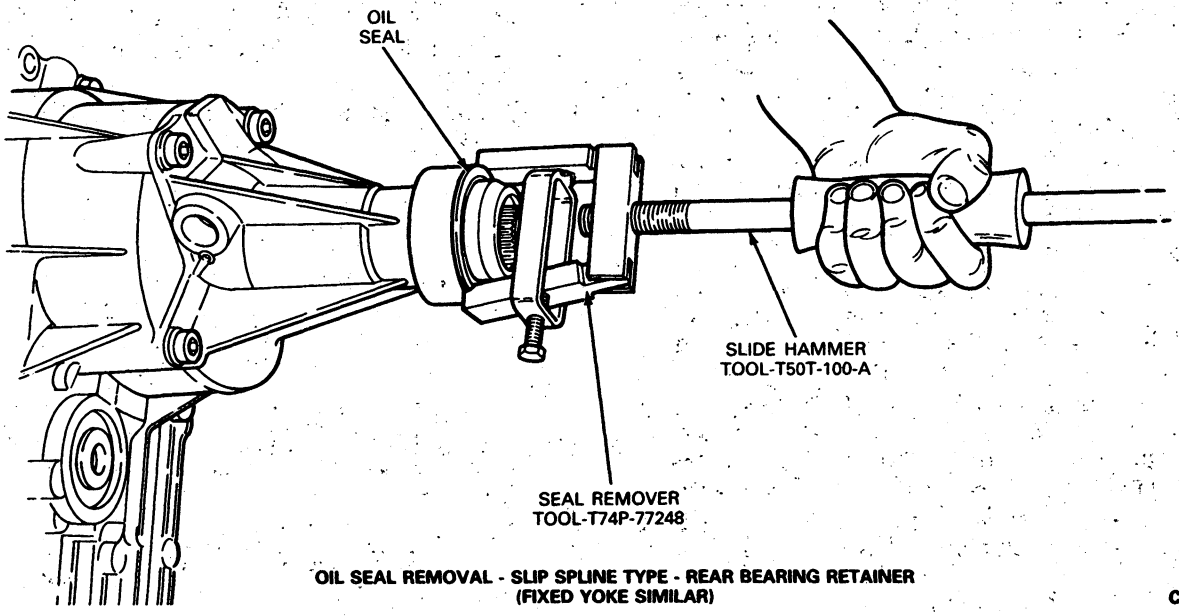
C7863-1A

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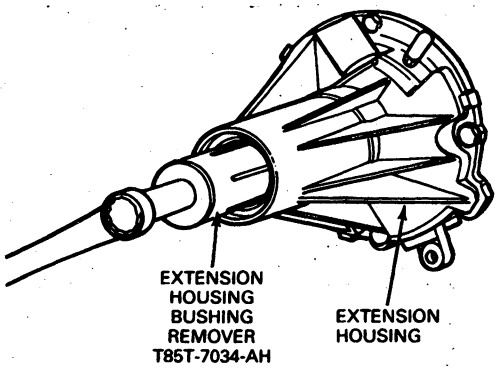
REMOVAL AND INSTALLATION (Continued)

Removal

1. Raise the vehicle on a hoist. Index the driveshaft to the transfer case and to the rear axle.
2. Disconnect the driveshaft at the rear axle flange and remove the driveshaft.
3. With a screwdriver, pry the oil seal from the bearing retainer. The seal may also be removed using Slide Hammer, T50T-100-A and Seal Remover, T74P-77248-A. Discard the oil seal.
4. Remove the bushing from the retainer with Extension Housing Bushing Remover, T85T-7034-AH. Discard the bushing.



OIL SEAL REMOVAL - SLIP SPLINE TYPE - REAR BEARING RETAINER (FIXED YOKE SIMILAR) C7864-2A



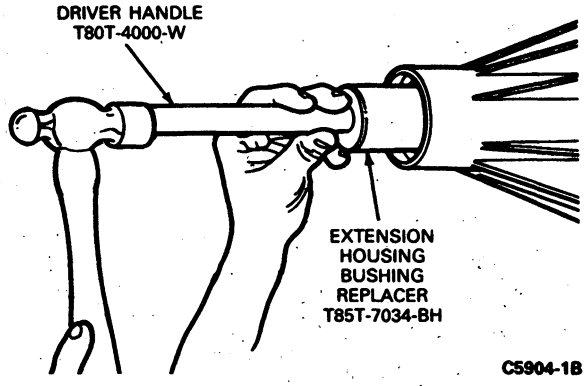
C7865-1A

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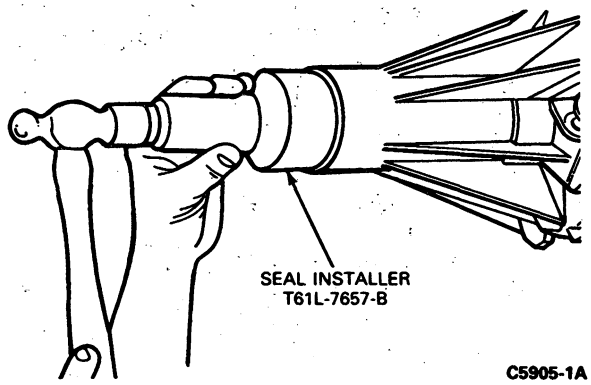
REMOVAL AND INSTALLATION (Continued)

Installation

1. Drive the bushing into the place in the retainer with Extension Housing Bushing Replacer, T85T-7034-BH and Driver Handle, T80T-4000-W.
2. Position the seal in the retainer so the notch on the seal faces upward and the drain hole in the rubber dust boot faces downward. Drive the seal in the retainer using Seal Installer, T61L-7657-B.
3. Position the driveshaft so it aligns with the index marks on the transfer case and rear axle. Install the driveshaft in the slip splines in the transfer case retainer. Install the driveshaft to the rear axle flange. Tighten the fasteners to the specified torque listed in the Section 15-60, General Driveshaft Service.



C5904-1B



C5905-1A

Rear Or Front Output Shaft With Fixed Yokes Oil Seal

Removal

1. Raise the vehicle on a hoist.
2. Remove the rear or front driveshaft from the transfer case output shaft yoke. Wire the driveshaft(s) out of the way.
3. Remove the output shaft yoke by removing the 30mm nut, steel washer and rubber seal from the rear or front output shaft and remove the yokes.
4. Remove the oil seal from the rear output housing bore with Seal Remover, T74P-77248-A, and Impact Slide Hammer, T50T-100-A.
5. Remove the oil seal slinger from each yoke.

Installation

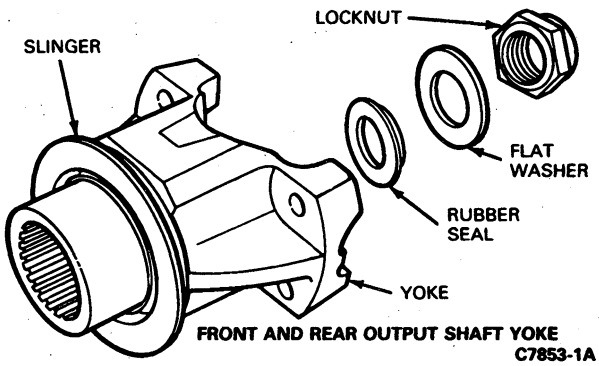
1. Make sure the output housing bore and face are free from nicks and burrs. Coat the oil seal with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C175-B) or automatic transmission fluid. Position the oil seal into the front or rear output housing bore, making sure that the oil seal is not cocked in the bore. Drive the oil seal into the bore with Output Shaft Seal Installer, T86T-7034-CH.
2. Install new oil seal slinger on each yoke. Do not scratch seal surface on yokes.
3. Install the yoke, rubber seal, steel washer and locknut on the front or rear output shafts. Tighten the nut to 203-244 N·m (150-180 ft-lb).
4. Connect the front or rear driveshaft to the transfer case output shaft yoke. Tighten the bolts to 83-118 N·m (61-87 ft-lb).
5. Lower the vehicle from the hoist.

DISASSEMBLY AND ASSEMBLY

Transfer Case

Disassembly

1. Remove transfer case from vehicle as described in this Section.
2. Drain fluid from case by removing filler plug from case half. Remove the speedometer cover. Replace the filler plug.
3. Remove both output shaft yoke nuts, washers, and rubber seals and remove the rear output yoke and the front output yoke from the transfer case.



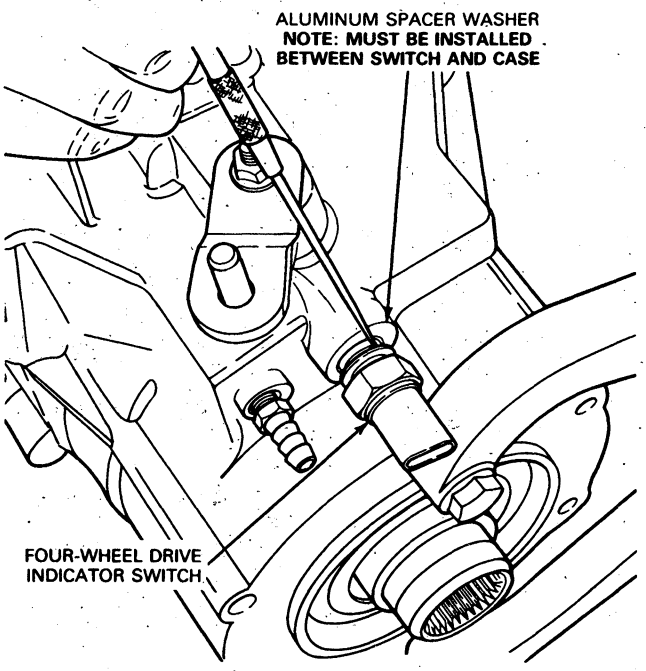
FRONT AND REAR OUTPUT SHAFT YOKE
C7853-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

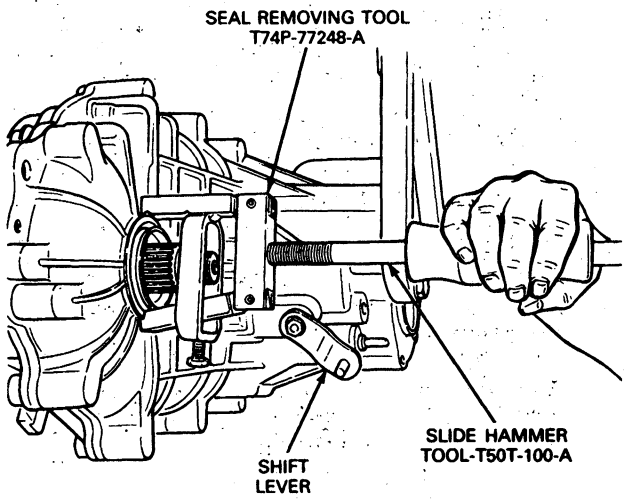
4. Remove the four-wheel drive indicator switch and aluminum washer from the transfer case. Do not lose this washer as it controls the operation of this switch.

REMOVAL FOUR-WHEEL DRIVE INDICATOR SWITCH



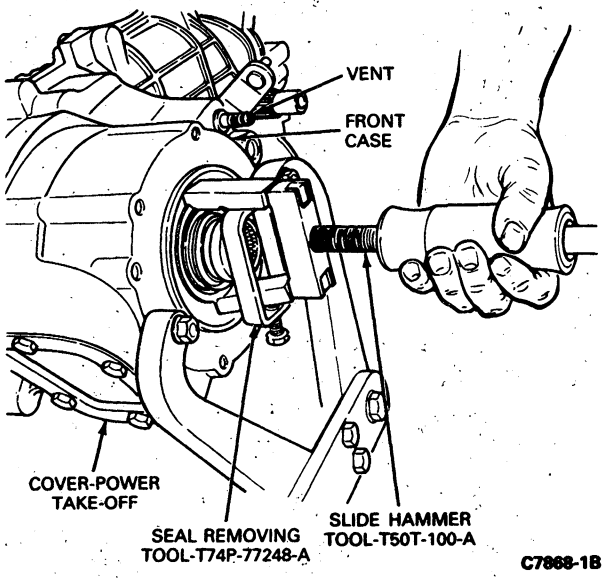
C7866-1A

5. Remove the front and rear output shaft yoke seals using Tool T74P-77248-A and T50T-100-A.
6. Remove the input shaft seals using same tools.



REMOVE FRONT OUTPUT SHAFT SEAL C7867-1B

REMOVE FRONT INPUT SHAFT SEAL



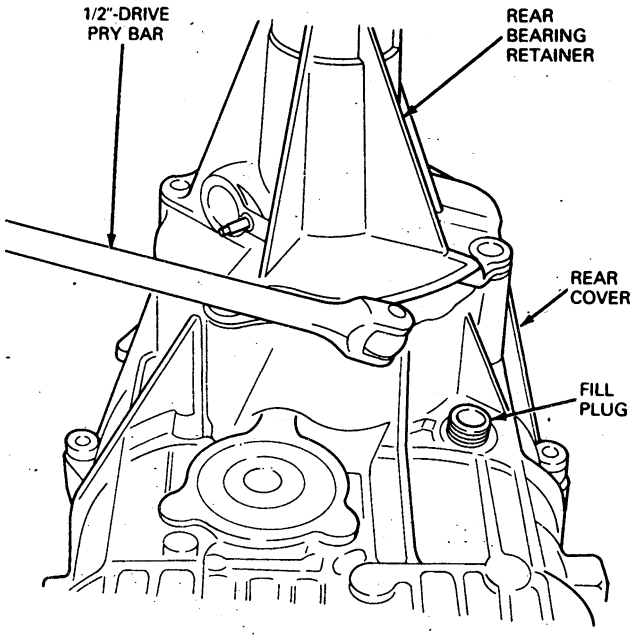
C7868-1B

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DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove the 4 No. 50 Torx® head bolts securing the rear bearing retainer to the cover. Pry the rear bearing retainer from the cover using a 1/2 inch drive breaker bar between the pry bosses and separate and remove the bearing retainer from the cover. Remove all traces of silicone rubber from the mating surfaces of the cover and the bearing retainer.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium cases.

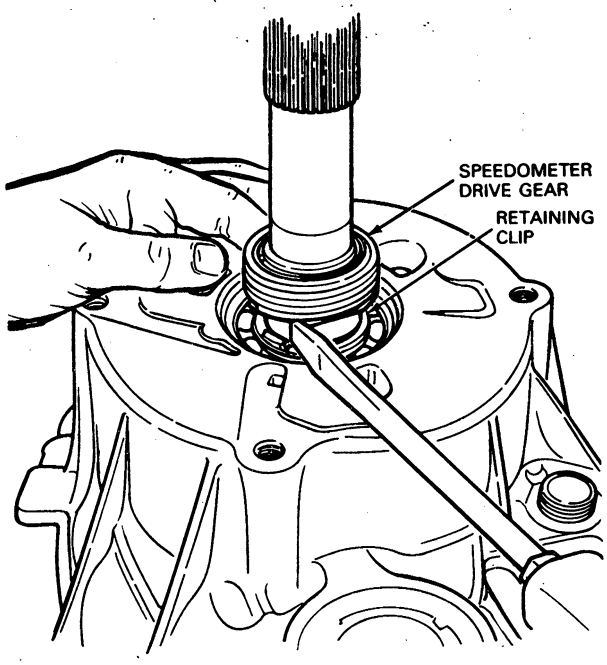


REMOVE REAR BEARING RETAINER

C7869-1A

8. Lift the rear output shaft and using a screwdriver, remove the speedometer gear retaining clip.
9. Slide the speedometer gear forward and remove the ball with a small magnet. The speedometer gear can now be removed off of the rear of the output shaft.
10. Remove the snap ring on the output shaft retaining the upper rear ball bearing using a suitable tool.

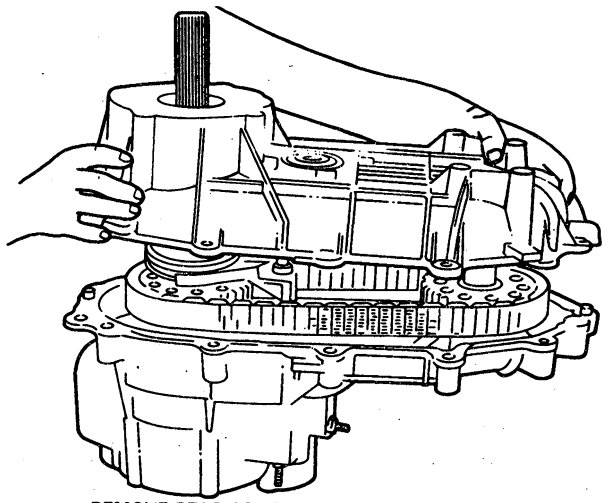
SPEEDOMETER DRIVE GEAR



C7870-1A

11. Remove the 12 No. 50 Torx® head bolts that retain the front case to the rear cover. Insert a 1/2 inch drive breaker bar between the pry bosses and separate. Lift the front case from the rear cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the front case and the rear cover.

CAUTION: When removing the silicone rubber, use care not to damage the mating surfaces of the magnesium housings.



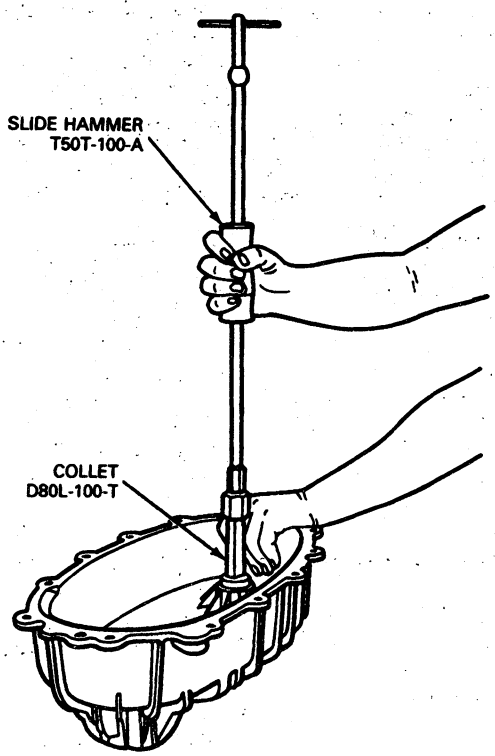
REMOVE REAR COVER FROM CASE ASSEMBLY

C7441-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

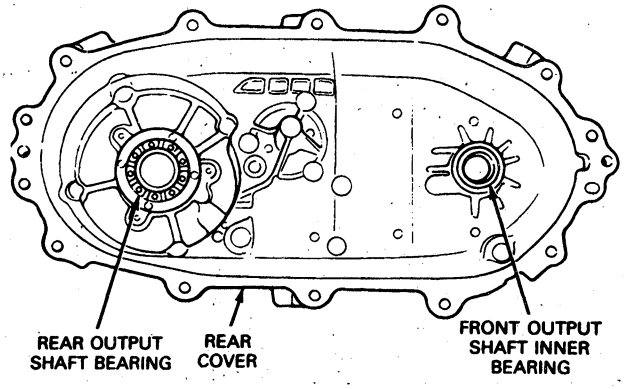
12. Remove front output shaft inner needle bearing from the rear cover with T50T-100-A, Slide Hammer, and D80L-100-T, Collet from D80L-100-A, Blind Hole Puller Set.



C9082-1A

13. Drive out the rear output shaft bearing from the inside of the case using appropriate tools.

REAR COVER - REAR OUTPUT SHAFT BEARING/
FRONT OUTPUT SHAFT INNER BEARING

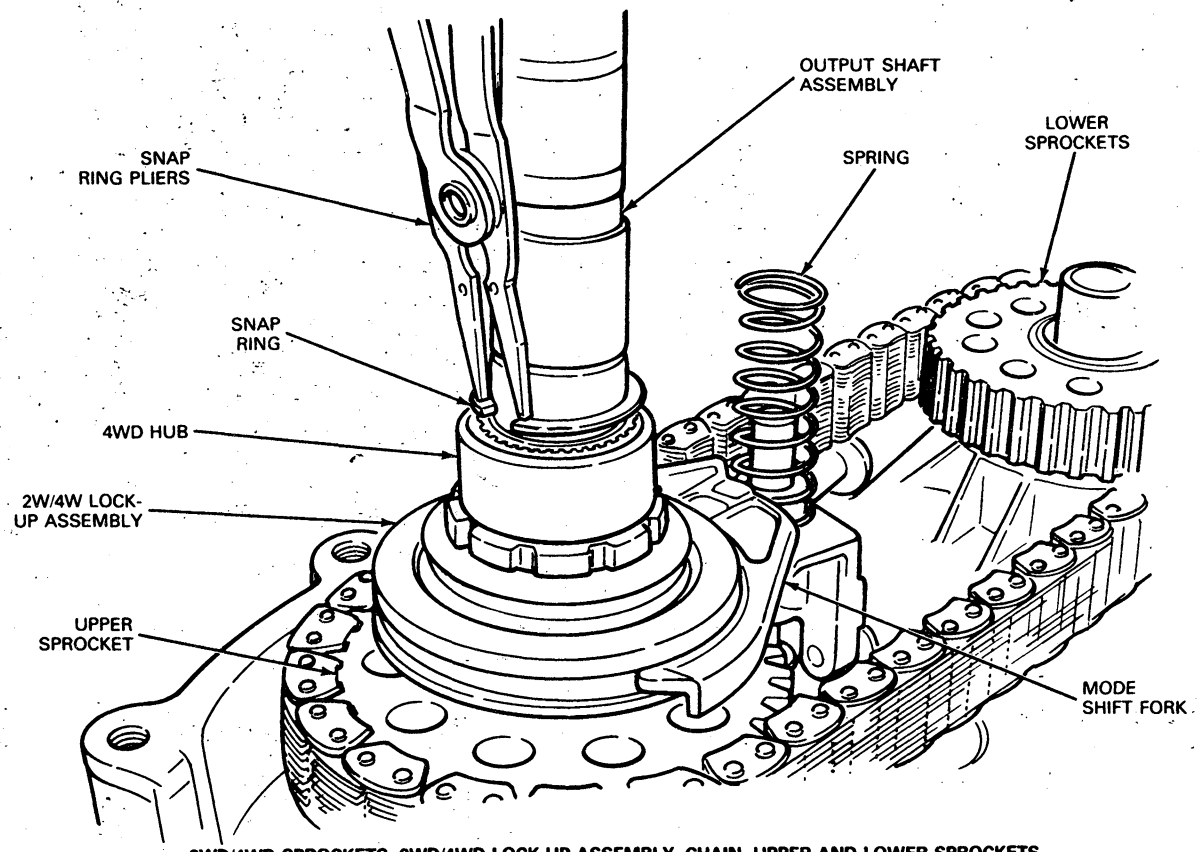


C7871-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

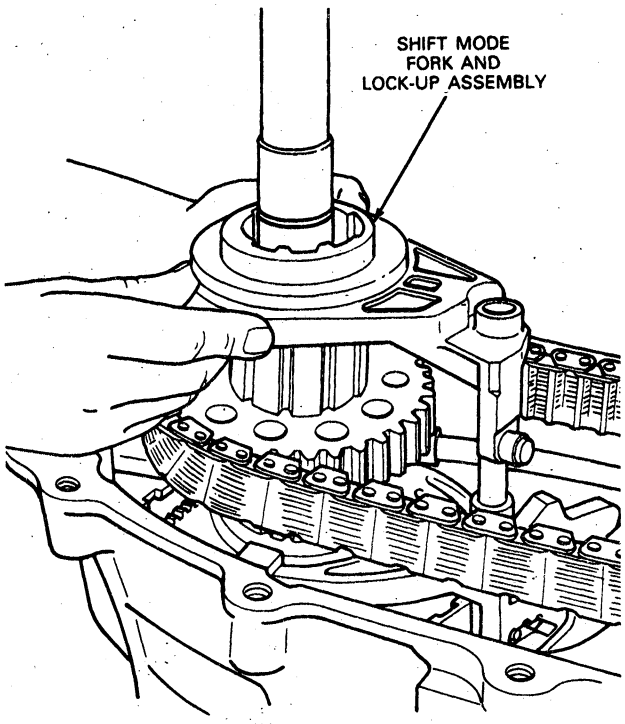
14. Remove the snap ring on the output shaft securing the clutch hub. Slide the 4WD hub off of the output shaft.
15. Remove the spring from the shift rail and lift the mode shift fork complete with the shifting collar from the upper sprocket spline.



2WD/4WD SPROCKETS, 2WD/4WD LOCK-UP ASSEMBLY, CHAIN, UPPER AND LOWER SPROCKETS C7872-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

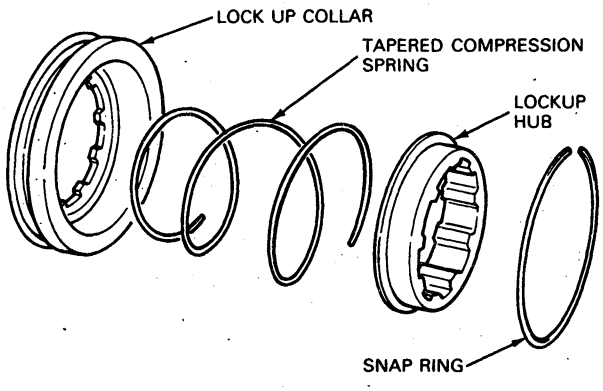


REMOVE SHIFT MODE FORK AND LOCK-UP ASSEMBLY

C7873-1A

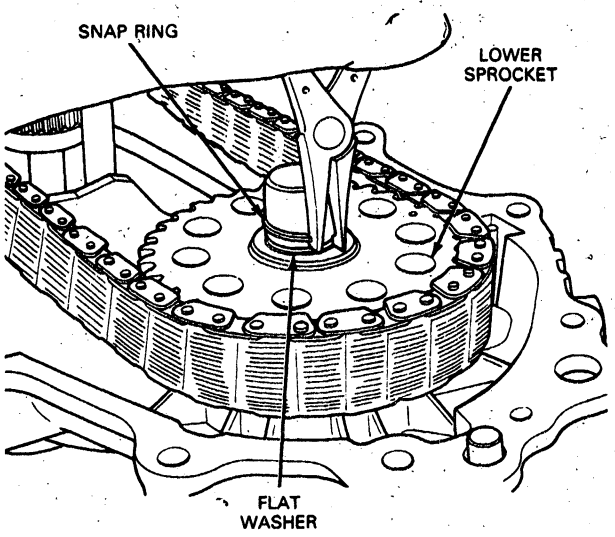
16. Disassemble the 2W-4W lockup assembly by removing the internal snap ring and pull the lockup hub and spring from the collar.

2W/4W LOCK UP COLLAR ASSEMBLY



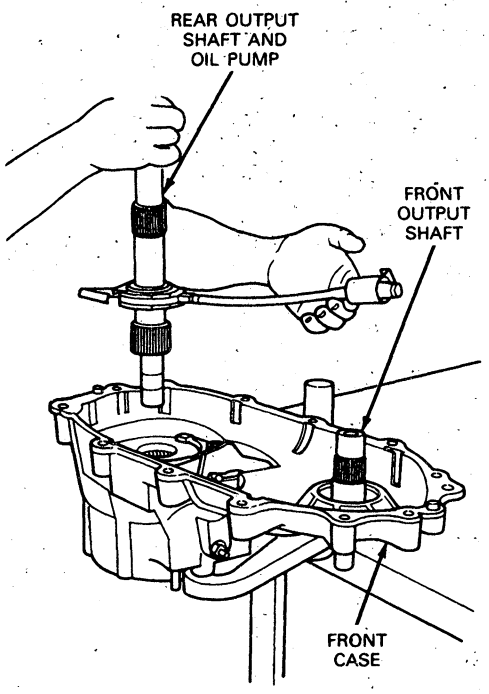
C7874-1A

17. Remove the snap ring retaining the lower sprocket to the lower output shaft. Grasp the upper and lower sprocket complete with the chain and lift them at the same time from the upper and lower output shafts.



REMOVE SNAP RING - LOWER SPROCKET

C7446-1A



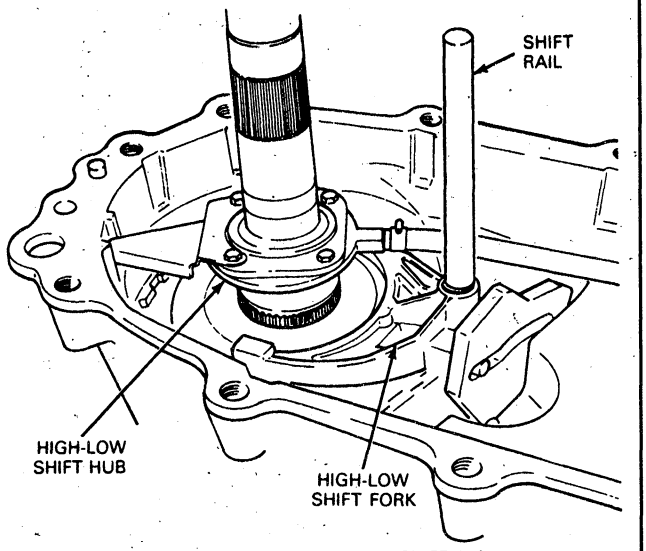
INSTALLATION - REAR OUTPUT SHAFT AND OIL PUMP

C7450-1A

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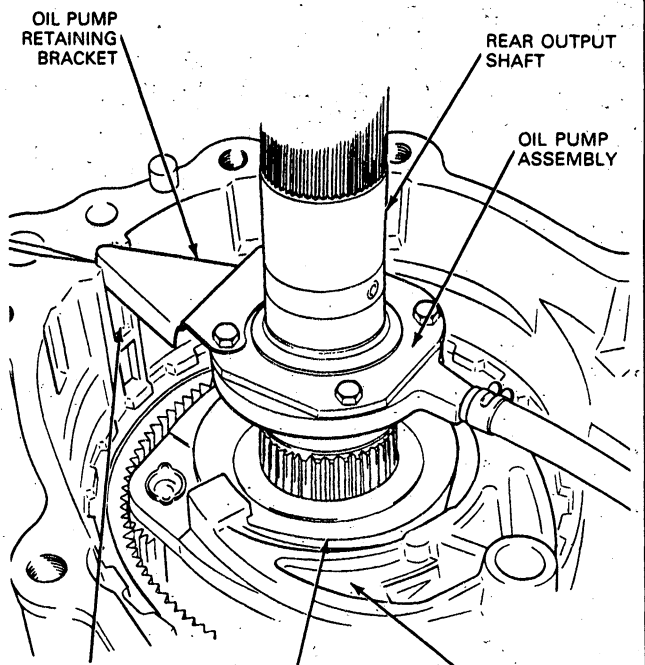
DISASSEMBLY AND ASSEMBLY (Continued)

18. Remove the shift rail by sliding it straight out from the shift fork.
19. Remove the high low shift fork by first rotating it until the roller is free from the cam then sliding out of engagement from the shifting hub.
20. Remove the chip collecting magnet from its slot in the case.



HIGH-LOW SHIFT FORK AND SHIFT RAIL C7875-1A

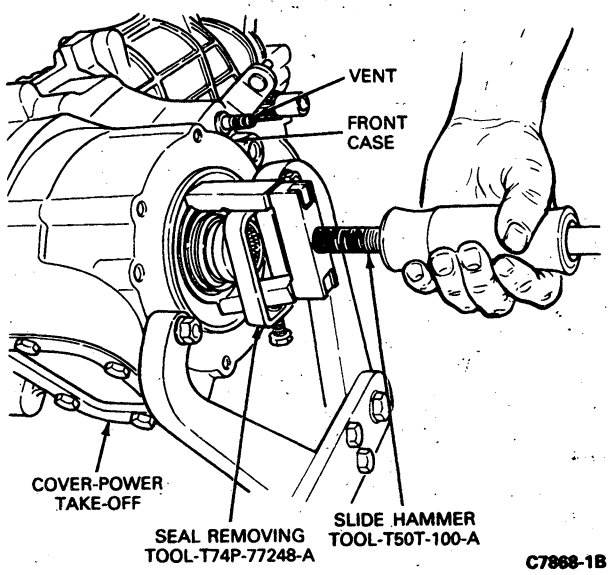
21. Lift out the pump screen and remove the output shaft assembly with the pump assembled on it. If the pump is to be disassembled, remove the four bolts from the pump body. Note the position of the pump front body, pins, spring, rear cover and pump retainer as removed.
22. Remove the high low shift hub.



REMOVE OUTPUT SHAFT ASSEMBLY WITH OIL PUMP ASSEMBLY C7876-1A

23. Remove the front output shaft from the case.
24. Turn the front case over and remove the front oil seal from the case using Tool T74P-77248-A and T50T-100-A.

REMOVE FRONT INPUT SHAFT SEAL

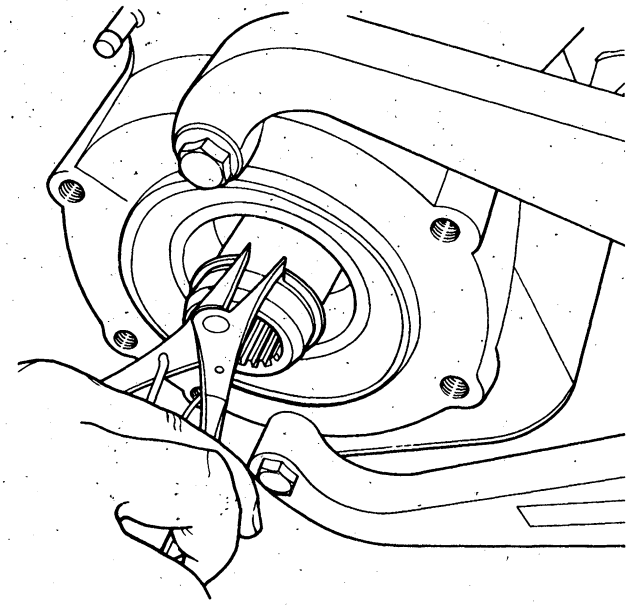


C7868-1B

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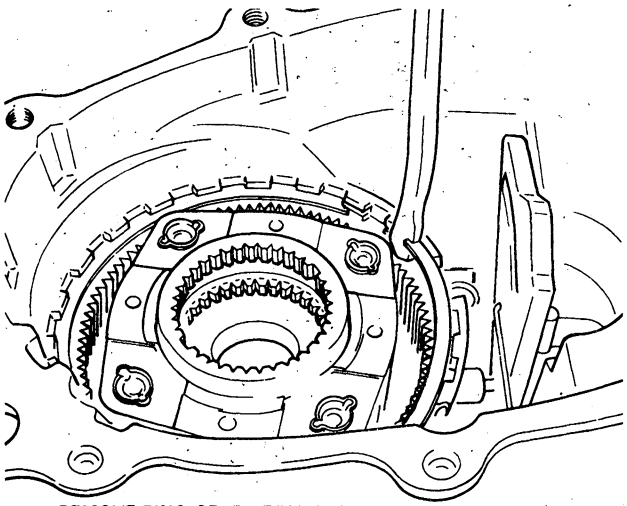
DISASSEMBLY AND ASSEMBLY (Continued)

25. Reaching through the front opening with a pair of snap ring pliers, expand the snap ring on the input shaft allowing it to drop out of the bearing. The carrier assembly, including the input shaft is serviced as an assembly only. If the bearing or bushing is to be replaced, drive out both of them through the input spline using suitable tools.



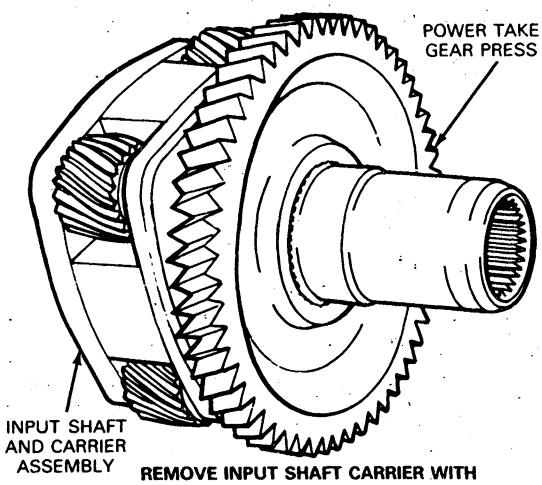
REMOVE INPUT SHAFT BEARING SNAP RING C7851-1A

26. Remove the ring gear by prying out the internal snap ring and lift out the gear.



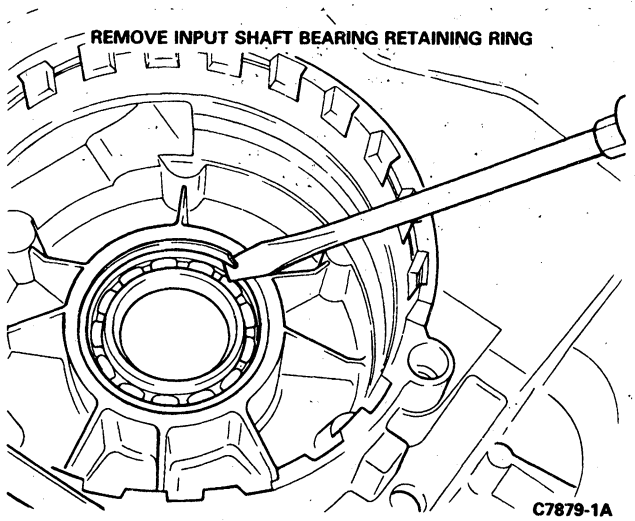
REMOVE RING GEAR RETAINING SNAP RING C7877-1A

27. Remove the PTO drive gear from the input shaft carrier assembly, if equipped, using appropriate tools.



REMOVE INPUT SHAFT CARRIER WITH POWER TAKE OFF GEAR C7878-1A

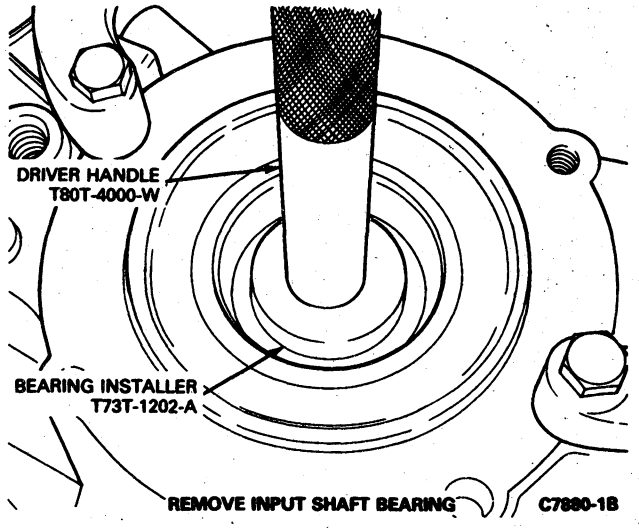
28. Remove the internal snap ring securing the input shaft bearing to the case and drive it out from the outside of the case using Tool T73T-1202-A and T80T-4000-W.



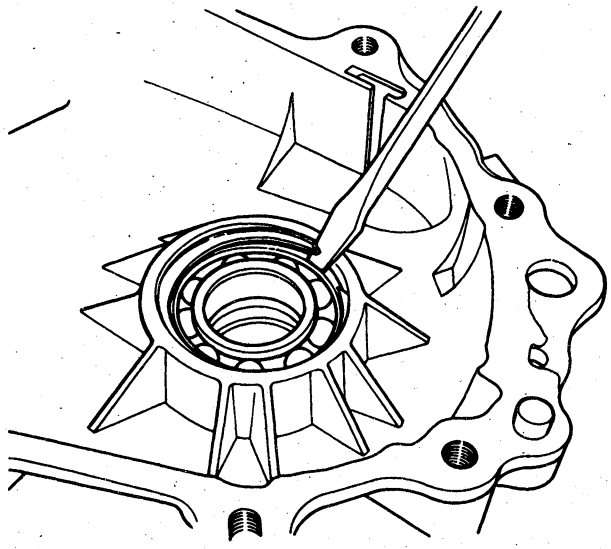
C7879-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

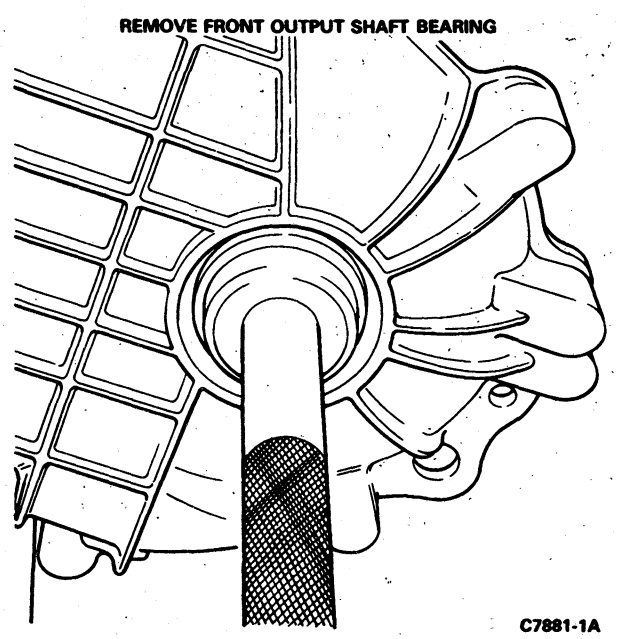


29. Remove the internal snap ring securing the front output shaft bearing in the magnesium housing and drive the bearing out from the front of the case using Tool T73T-1202-B and T80T-4000-W.



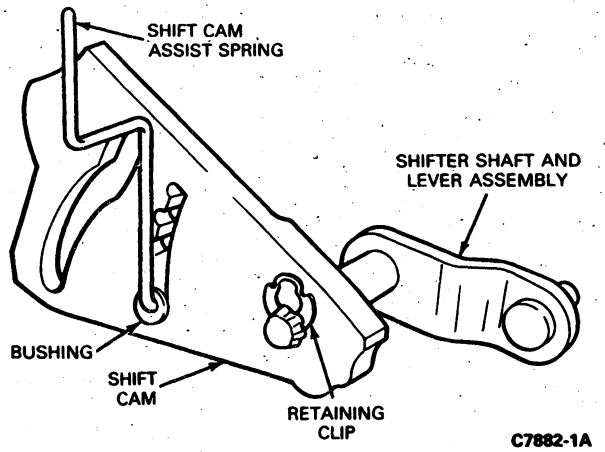
REMOVE FRONT OUTPUT SHAFT BEARING RETAINING SNAP RING

C7852-1A



30. Remove the shift cam by removing the retaining clip and sliding the shift shaft out of the case.
31. Remove the shift shaft seal by carefully prying it out of the case, being careful not to damage the magnesium.
32. Remove the shift cam, assist spring, and assist spring bushing from the case.

SHIFT CAM, LEVER AND SHAFT INSTALLATION

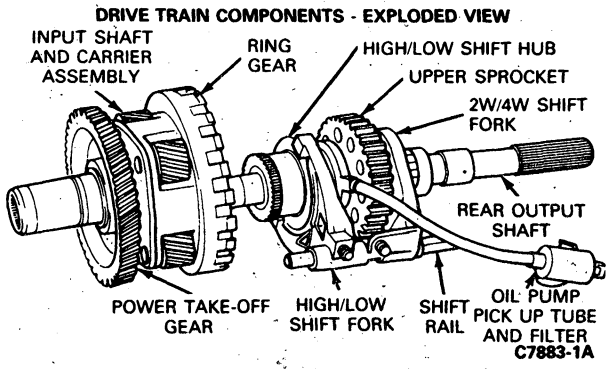


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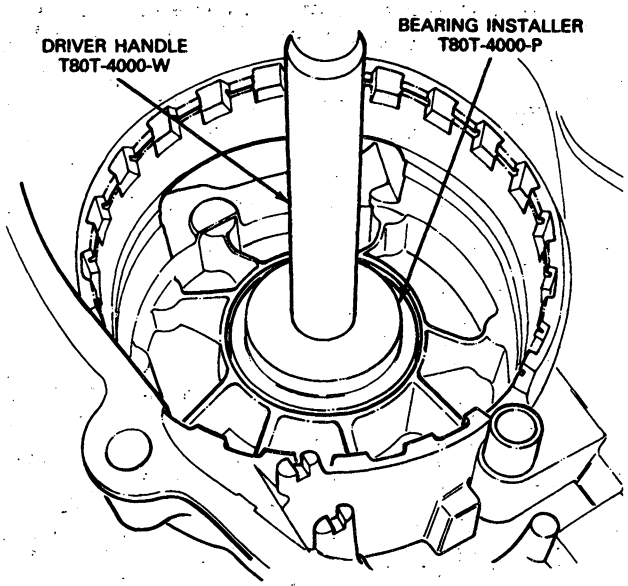
DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

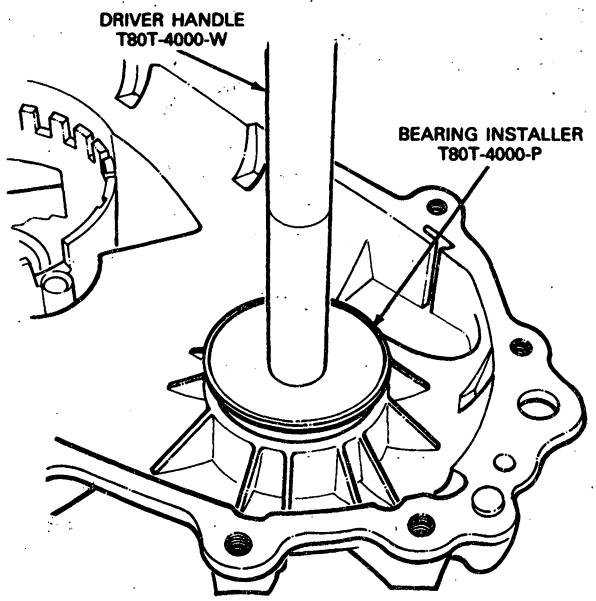
Before assembly, lubricate all parts with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent. Remove all chips from the bolt holes in the case and rear cover.



1. Install the input shaft and the front output shaft bearings in the case using appropriate tools. Install the internal snap rings retaining the bearings in the case.



2. Drive the front output shaft seal into the case until it is fully seated against the case using Tool T86T-7034-CH.

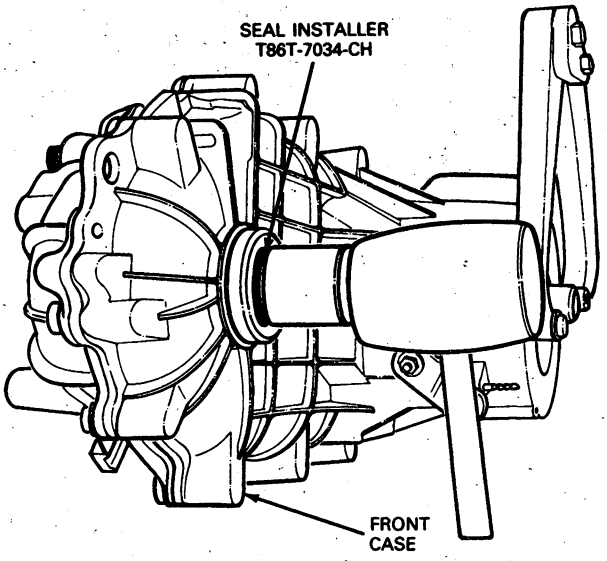


3. Install the front output shaft through the lower bearing. The front output shaft is held in place in the case by the front output yoke and oil seal slinger assembly. Install the front yoke assembly onto the front output shaft then the rubber seal, flat washer and 30mm locknut. Tighten the yoke locknut to 203-244 N·m (130-180 ft-lb).
4. Press the power take-off drive gear onto the input shaft assembly if it was removed.

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DISASSEMBLY AND ASSEMBLY (Continued)

5. Press the needle bearing and bronze bushing into the input shaft with the appropriate tools.

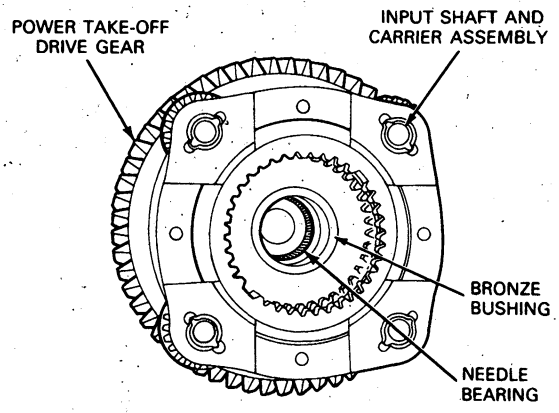


FRONT OUTPUT SHAFT SEAL INSTALLATION

C7886-1B

6. Install the ring gear into the slots in the case and retain it with the large internal snap ring making sure that it is fully seated.
7. Install the input shaft and carrier assembly in the case through the input shaft bearing being careful not to damage the gear teeth when aligning them with the ring gear teeth.
8. While supporting the carrier assembly in position, install a new snap ring on the front side of the input shaft bearing making sure that it is fully seated in the snap ring groove of the input shaft.

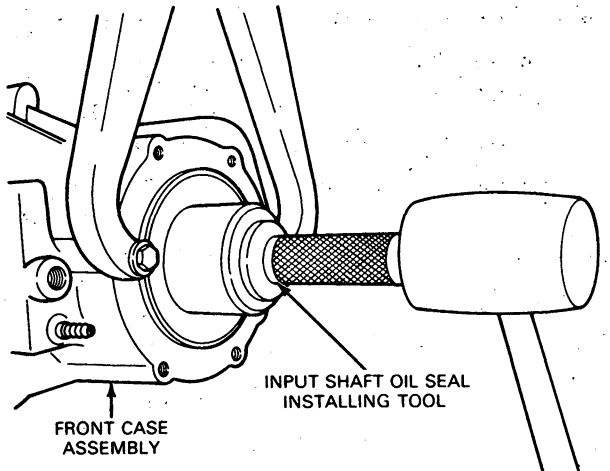
9. Install the upper input shaft oil seal into the case using an appropriate tool until it is fully seated against the case.



FRONT INPUT SHAFT AND CARRIER ASSEMBLY

C7887-1A

10. Install a new shifter shaft seal into the case using an appropriate tool.
11. Assemble the shift cam assembly into the case by sliding the shift shaft and lever assembly through the case and seal into engagement with the shift cam. Secure the shift cam with the retaining clip.



INSTALL FRONT INPUT SHAFT OIL SEAL

C7888-1A

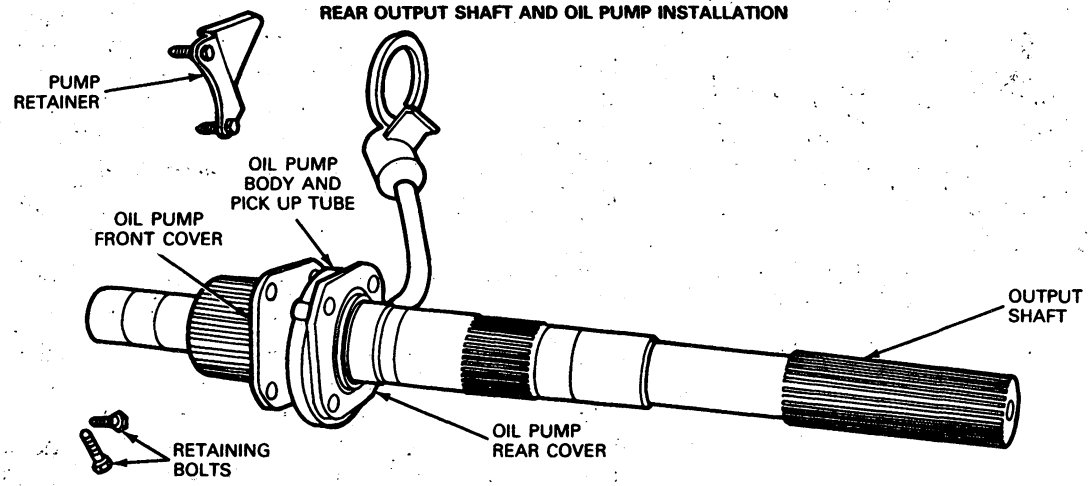
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DISASSEMBLY AND ASSEMBLY (Continued)

12. Install the shift cam assist spring in position in the bushing of the shift cam and in the recess in the case.
13. Assemble the pump and output shaft as follows: Place the oil pump cover with the word TOP facing the front of the front case. Install the two pins (with the flats facing upwards) with the spring between the pins and place the assembly in the oil pump bore in the output shaft. Place the oil pump body and pick up tube over the shaft and make sure that the pins are riding against the inside of the pump body. Place the oil pump rear cover with the words TOP REAR facing the rear of the case. The word TOP on the front cover and the rear cover should be on the same side. Install the pump retainer with the tabs facing the front of the transfer case. Install the four retaining bolts and rotate the output shaft while tightening the bolts to prevent the pump from binding. Tighten the bolts to 4.-4.5 N·m (36-40 in-lb). Lubricate the assembly with automatic transmission fluid.

NOTE: The output shaft must turn freely within the oil pump. If binding occurs, loosen the four bolts and retighten again.

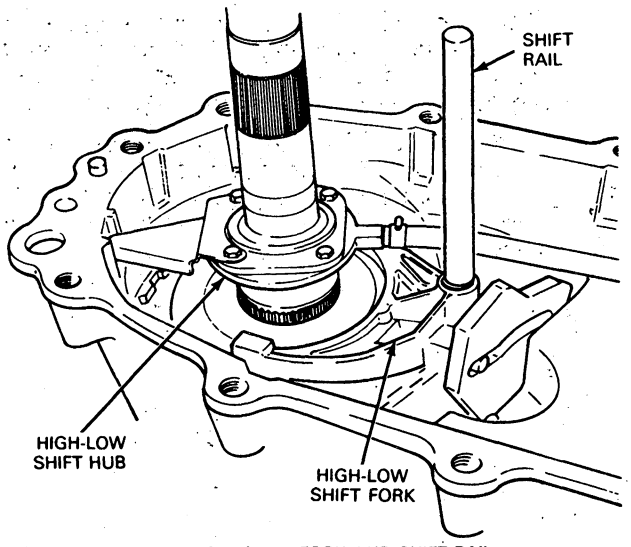
REAR OUTPUT SHAFT AND OIL PUMP INSTALLATION



C7889-2A

14. Install the high low shift hub.

    Install the high low shift fork by engaging it with the shift hub flange and rotating it until the roller is engaged with the lower groove of the cam.
15. Install the shift rail through the high low fork bore and into the rail bore in the case.



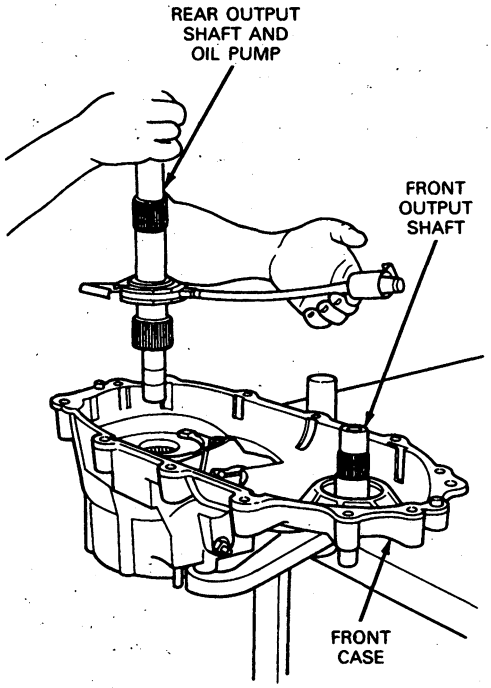
HIGH-LOW SHIFT FORK AND SHIFT RAIL

C7875-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

16. Install the output shaft and oil pump assembly in the input shaft. Make sure that the external splines of the output shaft engage the internal splines of the high low shift hub. Make sure that the oil pump retainer and oil filter leg are in the groove and notch of the front case. Install the collector magnet in the notch in the front case.

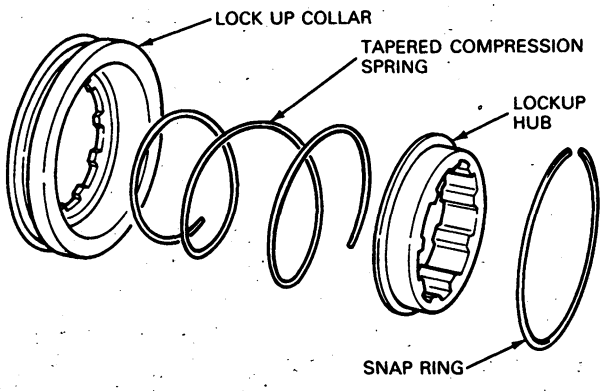


INSTALLATION - REAR OUTPUT SHAFT AND OIL PUMP

C7450-1A

17. Assemble the upper and lower sprockets with the chain and place them as an assembly over the upper and lower output shafts. Install the washer and the snap ring which retain the lower sprocket to the front output shaft.
18. Assemble the 2W-4W lockup assembly by installing the tapered compression spring in the lockup collar with the small end installed first. Place the lockup hub over the spring and compress the spring while installing the internal snap ring which holds the lockup assembly together.

2W/4W LOCK UP COLLAR ASSEMBLY

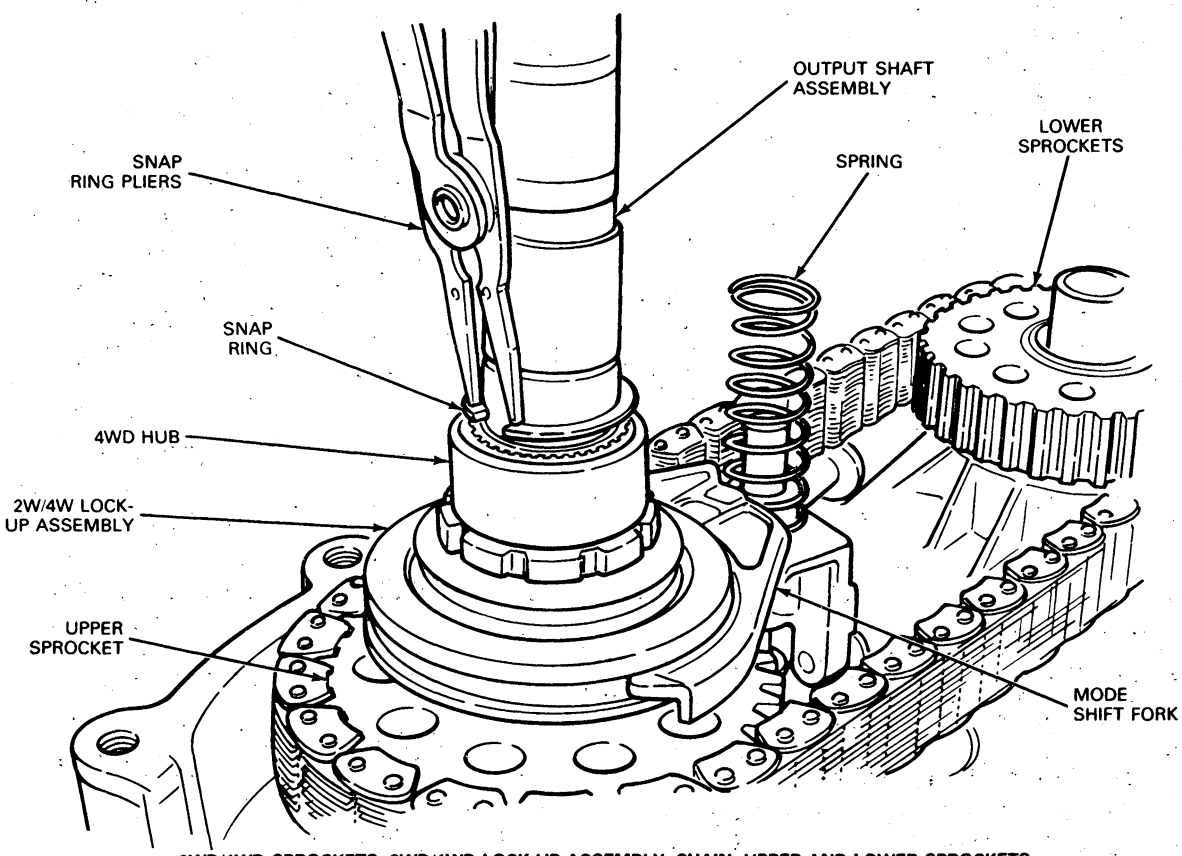


C7874-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

19. Install the lockup assembly and its shift fork over the external splines of the upper sprocket and the shift rail with the long boss of the shift rail facing forward.
20. Assemble the 4WD return spring over the shift rail and against the shift fork.
21. Place the 4WD hub over the external splines of the output shaft and secure with the appropriate snap ring. Make sure that the snap ring is fully seated in the snap ring groove.

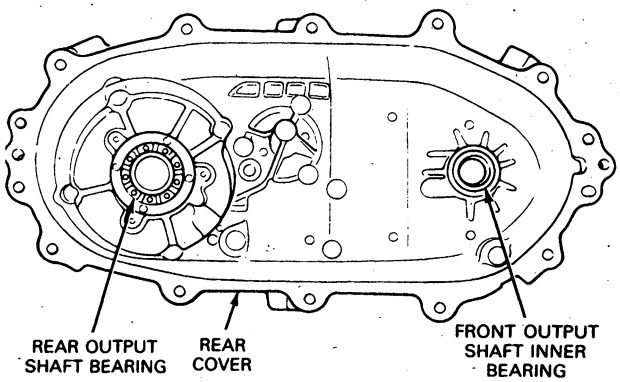


2WD/4WD SPROCKETS, 2WD/4WD LOCK-UP ASSEMBLY, CHAIN, UPPER AND LOWER SPROCKETS

C7872-2A

22. Press the lower output needle bearing in its bore in the rear cover using an appropriate tool.
23. Press the rear output shaft bearing into position in the cover using an appropriate tool. Install bearing snap ring retainer in cover.

REAR COVER - REAR OUTPUT SHAFT BEARING/ FRONT OUTPUT SHAFT INNER BEARING

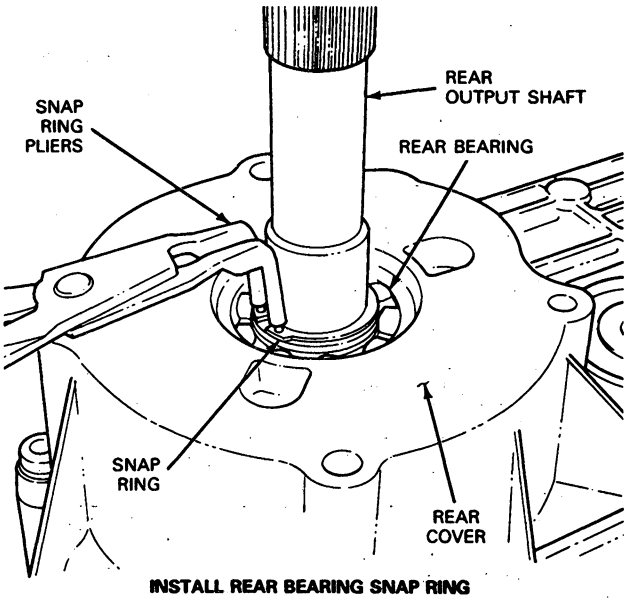


C7871-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

24. Install the rear output shaft oil seal in the bearing retainer using the appropriate tool making sure that it is fully seated.
25. Coat the mating surface of the front case with a bead of non-acid cure Silicone Rubber E7TZ-19562-A (ESL-M4G273-A).
26. Place the cover on the case making sure that the lower output shaft, shift shaft and shift rail are aligned. Install and tighten the 12 No. 50-Torx® head case to cover bolts to 30-49 N·m (22-36 ft-lb).
27. Install the rear bearing snap ring on the output shaft making sure that the snap ring is fully seated in the groove of the shaft.

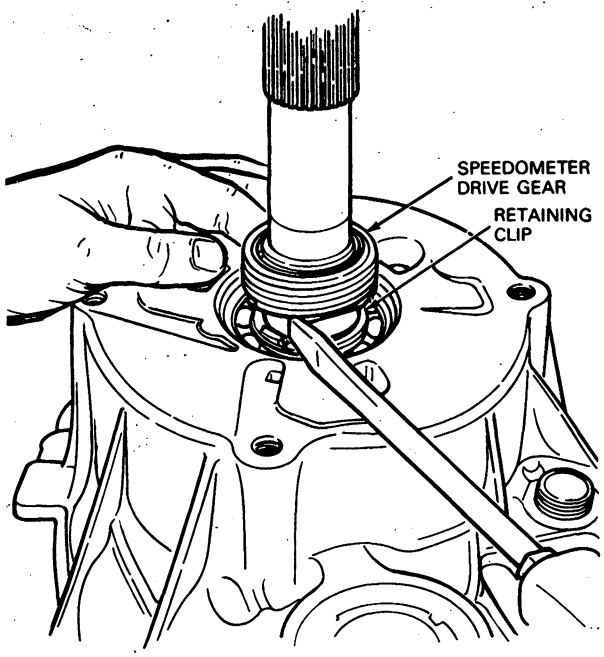


INSTALL REAR BEARING SNAP RING

C7439-1B

28. Place the speedometer drive gear over the shaft with the slot aligned with the hole for the drive ball. The gear should go completely against the snap ring which retains the output shaft. Place the ball in the hole and pull the speedometer gear over the ball. Snap the retaining clip between the snap ring and the speedometer gear.

SPEEDOMETER DRIVE GEAR



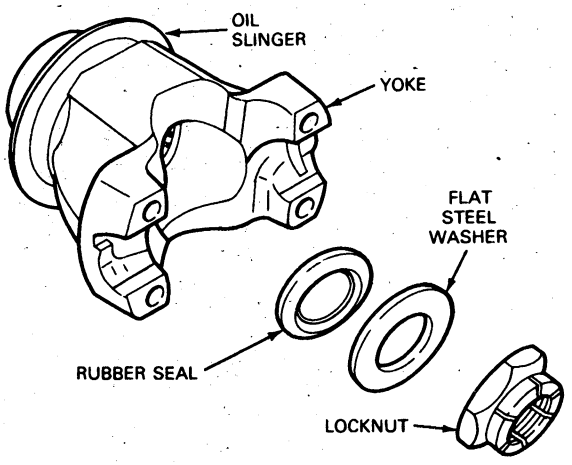
C7870-1A

29. Apply a bead of non-acid cure Silicone Rubber ET7Z-19562-A (ESL-M4G273-A) to the face or the rear bearing retainer or rear slip yoke extension housing.
30. Place the rear bearing retainer or rear slip yoke extension housing in its position and secure with the 4 Torx® bolts tightened to 30-49 N·m (22-36 ft-lb).
31. On transfer case with slip yoke rear bearing retainer housing remove the extension oil seal using Tool T74P-77248-A and T50T-100-A. Remove the extension housing bushing using Tool T85T-7034-AH. Install a new bushing using Tool T85T-7034-BH and T80T-4000-W. Install a new seal using Tool T61L-7657-B.

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DISASSEMBLY AND ASSEMBLY (Continued)

32. Install the rear output shaft yoke and slinger assembly onto the rear splines of the output shaft. Install the rubber seal, flat steel washer and 30mm locknut on the output shaft and tighten to 203-244 N·m (150-180 ft-lb).
33. Install the drain plug and tighten to 19-30 N·m (14-22 ft-lb).
34. Install the 4WD indicator lamp switch and aluminum washer into the case.
35. Place a 3/8 inch drive ratchet in the fill plug and remove the plug. Fill the transfer case with 64 oz. of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent.
36. Install the fill plug and tighten to 19-30 N·m (14-22 ft-lb).
37. Install the transfer case as described in the Removal and Installation portion of this Section.
38. Start engine, check transfer case for correct operation. Stop engine and check fluid level. Fluid should drip out of "level" hole. If fluid flows out of "level" hole, the oil pump may not be functioning properly.



REAR YOKE INSTALLATION C7890-1A

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 lb.	Universal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-T	Collet	Universal 1-1/4" to 1-1/2"
D80L-100-H	Actuator Pin	Use with Blind Hole Puller
TOOL-1175-AC	Seal Remover	Universal — Use with Impact Slide Hammer
T80T-7127-B	Output Bearing Replacer — Front	Borg Warner #1356 Transfer Case
T80T-7127-C	Output Bearing Replacer — Rear	Borg Warner #1356 Transfer Case
T80T-4000-P	Bearing Installer	Borg Warner #1356 Transfer Case
T74P-77248-A	Oil Seal Remover	Borger Warner #1356 Transfer Case
T61L-7657-B	Oil Seal Installer	Borg Warner #1356 Transfer Case
T85T-7034-AH	Extension Housing Bushing Remover	Borg Warner #1356 Transfer Case
T85T-7034-BH	Extension Housing Bushing Installer	Borg Warner #1356 Transfer Case
T80T-4000-W	Driver Handle	Borg Warner #1356 Transfer Case
T86T-7034-CH	Oil Seal Installer	Borg Warner #1356 Transfer Case
T73T-1202-B	Bearing Insatller	Borg Warner #1356 Transfer Case
T73T-1202-A	Bearing Installer	Borg Warner #1356 Transfer Case
T83T-7065-B	Output Shaft Seal Installer	Borg Warner #1356 Transfer Case

CC7858-2B

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SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

Description	Torque Limits	
	N·m	Ft-Lbs
Case Half Attaching Bolts	48-54	35-40
Four Wheel Drive Indicator Switch	11-16	8-12
Front and Rear Output Yokes to Transfer Case	163-203	120-150
Drain Plug	19-30	14-22
Fill Plug	19-30	14-22
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke	11-20	8-15
Rear Driveshaft to Rear Output Yoke — Bolt — Bronco	28-33	20-28
Rear Driveshaft to Rear Output Yoke — Nut — F150-F350 4x4	11-20	8-15

CC7859-2C

ROTUNDA EQUIPMENT

Number	Description
077-00019	Transmission Jack
071-00002	Gasket Compound

CC7406-1B

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SECTION 16-86 Borg-Warner 1345 Transfer Case

SUBJECT	PAGE
DESCRIPTION	16-86-1
DIAGNOSIS AND TESTING	16-86-1
DISASSEMBLY AND ASSEMBLY	
Case	16-86-9
Cover	16-86-8
Planetary Gear Set	16-86-8
Transfer Case	16-86-2
REMOVAL AND INSTALLATION	
Shift Lever	16-86-2
Transfer Case	16-86-1
SPECIFICATIONS	16-86-10
VEHICLE APPLICATION	16-86-1

VEHICLE APPLICATION

Applies to Bronco, F-150, F-250 and F-350 (4x4) Models.

DESCRIPTION

The Borg-Warner 1345 is a two-piece all aluminum part time transfer case (Figs. 1 and 2). The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle for extended distances without disconnecting the rear driveshaft.

DIAGNOSIS AND TESTING

Refer to Section 16-10, General Manual Transmission Service, for diagnosis and testing procedures.

REMOVAL AND INSTALLATION

Transfer Case

Refer to Fig. 3.

Removal

1. Raise vehicle on a hoist.
2. Place a drain pan under transfer case, remove drain plug and drain fluid from transfer case.
3. Disconnect four wheel drive indicator switch wire connector at transfer case.
4. If so equipped, remove skid plate from frame.

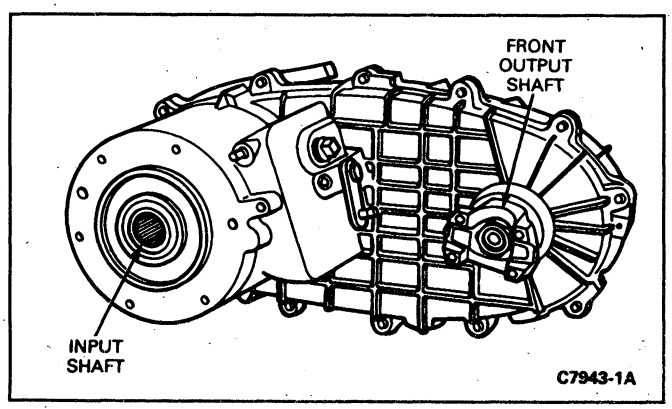


FIG. 1 Borg-Warner 1345 Transfer Case—Front View Case Half

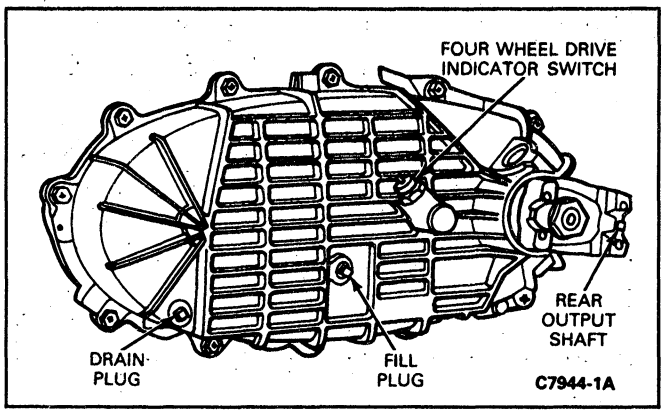


FIG. 2 Borg-Warner 1345 Transfer Case—Rear View Cover Half

5. Disconnect front driveshaft from front output yoke.
6. Disconnect rear driveshaft from rear output shaft yoke.
7. Disconnect speedometer driven gear from transfer case rear bearing retainer.
8. Remove the shift rod from the transfer case control lever and transfer case shift lever.
9. Disconnect vent hose from transfer case.
10. Support transfer case with a transmission jack Rotunda number 077-00019 or equivalent.
11. Remove the bolts retaining transfer case to transmission adapter.
12. Slide transfer case rearward off of the transmission output shaft and lower tranfer case from vehicle and remove gasket between transfer case and adapter.

Installation

1. Place a new gasket between transfer case and adapter.
2. Raise transfer case with transmission jack so transmission output shaft aligns with splined transfer case input shaft. Slide transfer case forward on to transmission output shaft and onto the dowel pin. Install bolts retaining transfer case to adapter. Tighten bolts in the torque sequence shown in View V, Fig. 3.
3. Remove transmission jack from transfer case.

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4. Connect rear driveshaft to rear output shaft yoke. For Bronco tighten bolt to 28-33 N·m (20-28 ft-lb) for F-150—F-350 (4x4) tighten nut to 11-20 N·m (8-15 ft-lb).
5. Attach the shift rod to transfer case shift lever and transfer case control rod.
6. Connect speedometer driven gear to transfer case.
7. Connect four wheel drive indicator switch wire connector at transfer case.
8. Connect front driveshaft to front output yoke. Tighten nut to 11-20 N·m (8-15 ft-lbs).
9. Install skid plate to frame. Tighten nuts and bolts to specification.
10. Install drain plug and tighten to 9-18 N·m (6-14 ft-lbs). Remove filler plug and install 3.1 liters (6.5 pints) of automatic transmission fluid, DEXRON® II, XT-2-QDX (ESP-M2C138-CJ) or equivalent. Install filler plug and tighten to 21-33 N·m (15-25 ft-lbs).
11. Lower vehicle.

Shift Lever

Refer to Fig. 3.

NOTE: Remove the shift ball only if the shift ball, boot or lever is to be replaced. If either the ball, boot or lever is not being replaced, remove the ball, boot and lever as an assembly.

Removal

1. Remove the plastic insert from the shift ball. Warm the ball with a heat gun to 60°-82°C (140°-180°F). Knock the ball off the lever with a block of wood and a hammer, taking care not to damage the finish on the shift lever.
2. Remove the rubber boot and floor pan cover.
3. Disconnect the vent hose from the shift lever.
4. Disconnect the transfer case shift rod from the shift lever.
5. Remove the bolt retaining the shift lever to transfer case. Remove the shift lever and bushings.

Installation

1. Position the shift lever and bushings on the transfer case. Install the bolt and tighten to 95-122 N·m (70-90 ft-lbs).
2. Coat the pivots on the shift lever and transfer case lever with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Install the shift rod on the pivots.
3. Connect the vent hose to the shift lever.
4. Install the rubber boot and floor pan cover.
5. Warm the ball with a heat gun to 60°-82°C (140°-180°F) and tap the ball on the lever with a 7/16 inch socket and mallet. Install the plastic shift pattern insert.
6. Check the transfer case for proper shifting and operation.

DISASSEMBLY AND ASSEMBLY

Transfer Case

Refer to Fig. 4.

Disassembly

1. Remove transfer case from vehicle as described in this Section.
2. Drain fluid from case by removing drain plug from rear case half (Fig. 2). Remove the speedometer cover. Replace the filler plug.
3. Remove both output shaft yoke nuts and washers and remove the rear output yoke and the front output yoke.
4. Remove the four-wheel drive indicator switch.
5. Separate the cover from the case by removing the attaching bolts. Pry the case and cover apart by inserting a flat-blade screwdriver or 1/2 inch square drive ratchet or breaker bar in the pry bosses (Fig. 5).
6. Remove the magnetic chip collector from the boss in the bottom of the case half.
7. Slide the shift collar hub off the rear output shaft (Fig. 6).
8. Compress the shift fork spring (Fig. 7) and remove the upper and lower spring retainers from the shaft.
9. As an assembly, lift out from the case the four-wheel drive lockup fork and the lockup shift collar (Fig. 8). Be careful not to lose the nylon wear pads on the lockup fork. Note the location holes on the nylon wear pad and lockup fork.
10. Remove the snap ring from the front output shaft and remove the thrust washer.
11. Grip the chain and both sprockets, (Fig. 9) and lift straight up to remove the drive sprocket, driven sprocket and chain from the output shafts. Remove the thrust washer from the rear output shaft.
12. Lift the front output shaft out from the case.
13. Remove the four oil pump attaching bolts and remove the oil pump rear cover, pickup tube, filter and pump body, two pump pins, pump spring, and oil pump front cover from the rear output shaft (Fig. 10). Disconnect oil pick-up tube from pump body.
14. Remove the snap ring that holds the bearing retainer inside the case. Lift the rear output shaft while tapping on the bearing retainer with a plastic or soft mallet. Lift the rear output shaft and bearing retainer from the case (Fig. 11).

    NOTE: Two dowel pins will fall into the case when the retainer is removed.
15. Remove the rear output shaft from the bearing retainer. If necessary, press the needle bearing assembly out from the bearing retainer.
16. Remove the C-clip that holds the shift cam (Fig. 12) to the shift actuating lever inside the case.
17. Remove the shift lever retaining screw and remove the shift lever from the case.

    NOTE: When removing the lever, the shift cam will disengage from the shift lever shaft and may release the detent ball and spring from the case.
18. As an assembly, remove the planetary gear set, shift rail, shift cam, input shaft and shift forks from the case (Figs. 13 and 14). Be careful not to lose the two nylon wear pads on the shift fork.
19. Remove the spacer washer from the bottom of the case. Remove the bushing.

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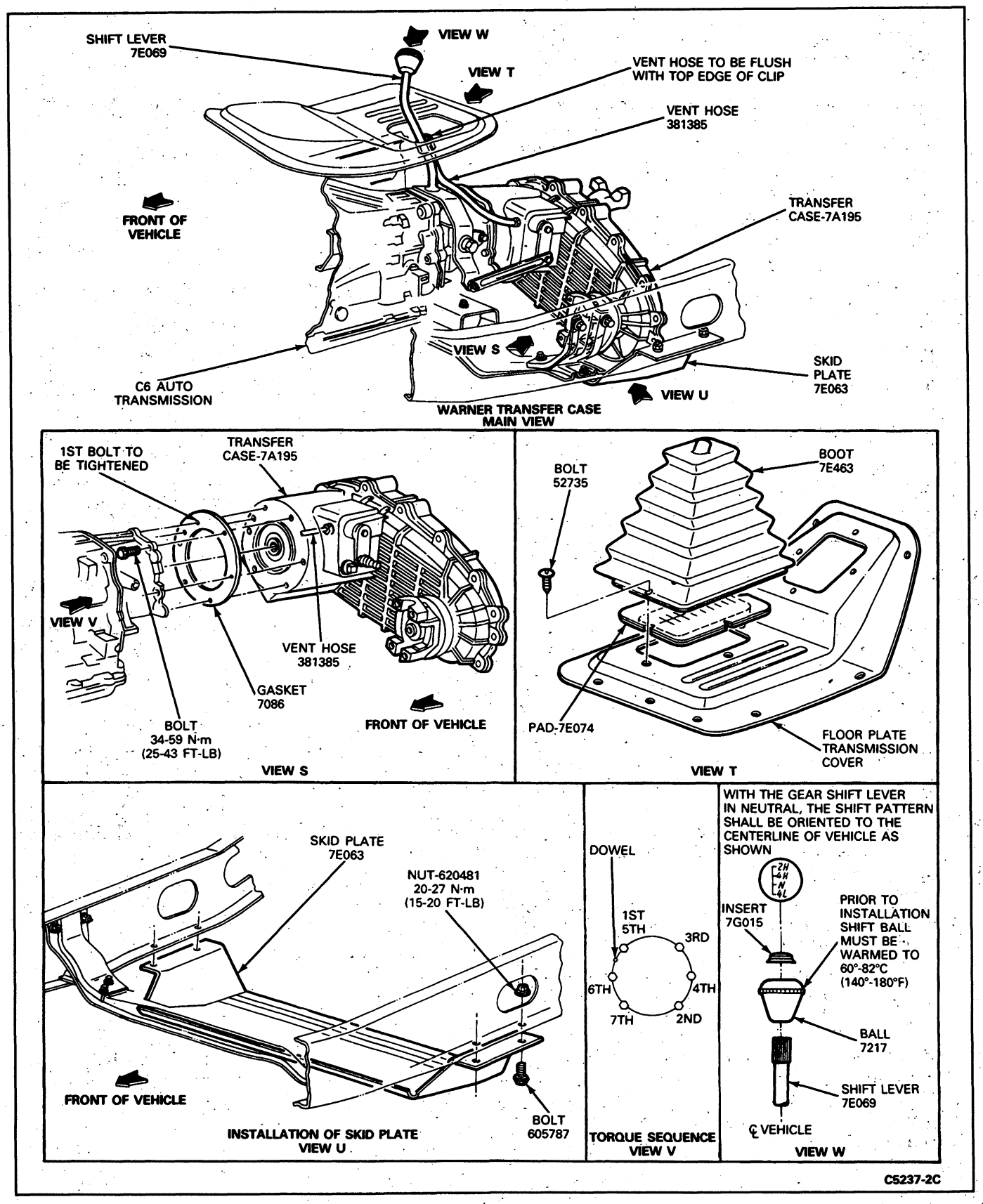


FIG. 3 Borg-Warner 1345 Transfer Case and Skid Plate Installation

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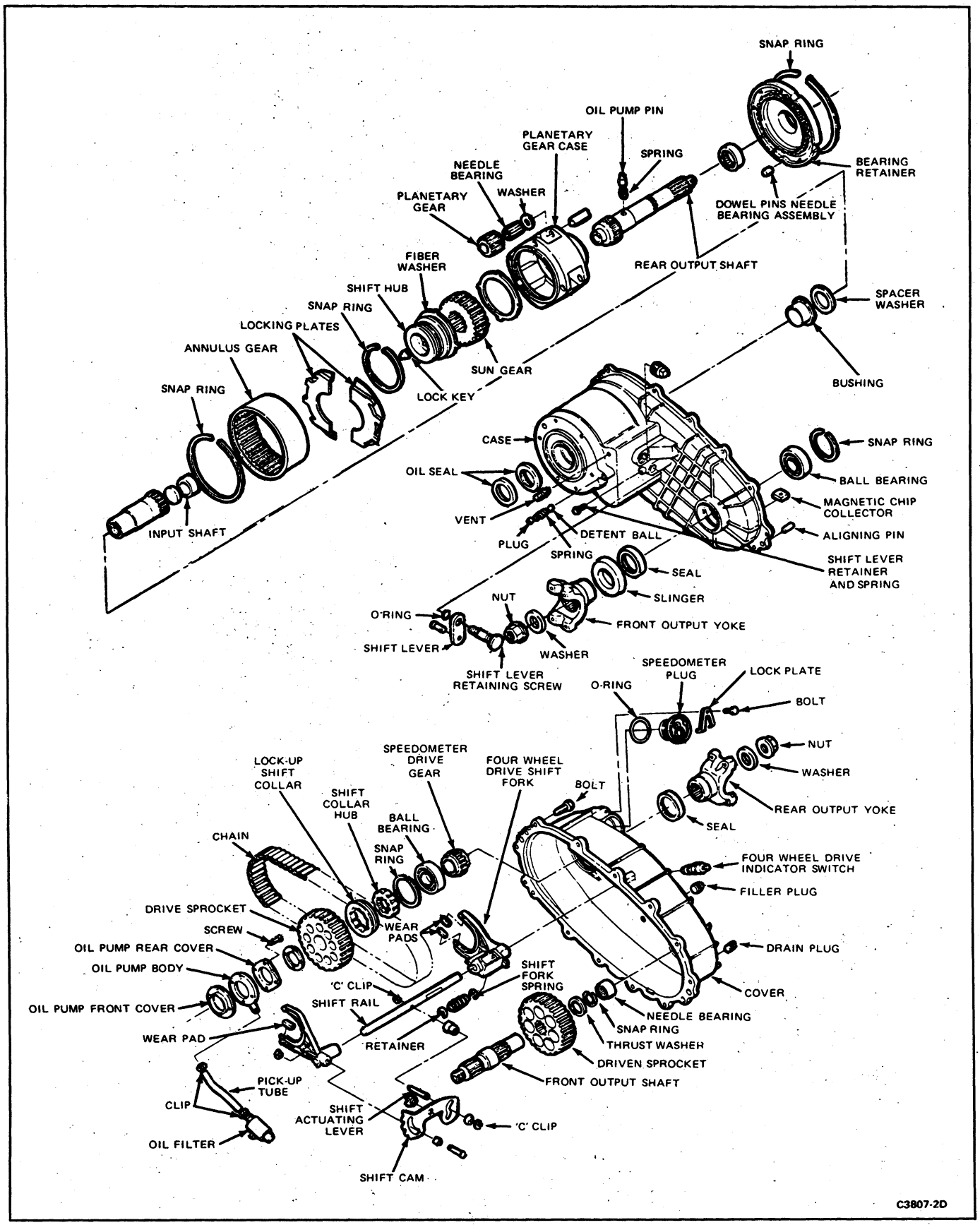


FIG. 4 Borg-Warner 1345 Transfer Case Exploded View

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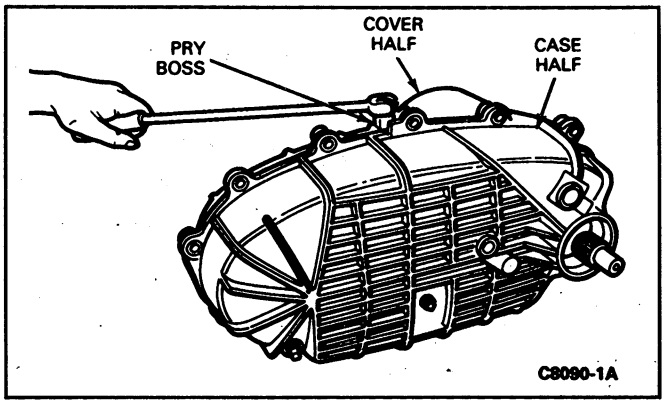


FIG. 5 Separating Case and Cover Halves

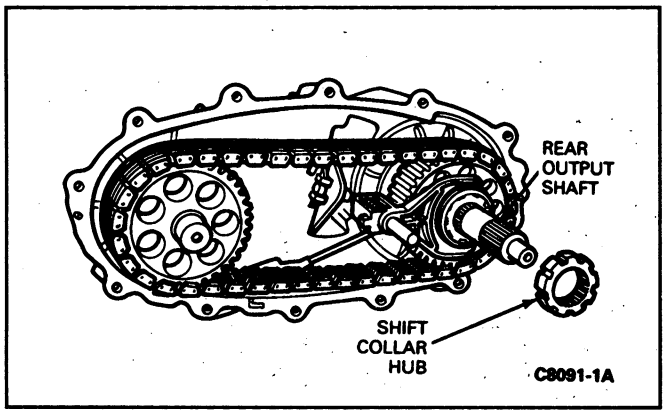


FIG. 6 Removing Shift Collar Hub

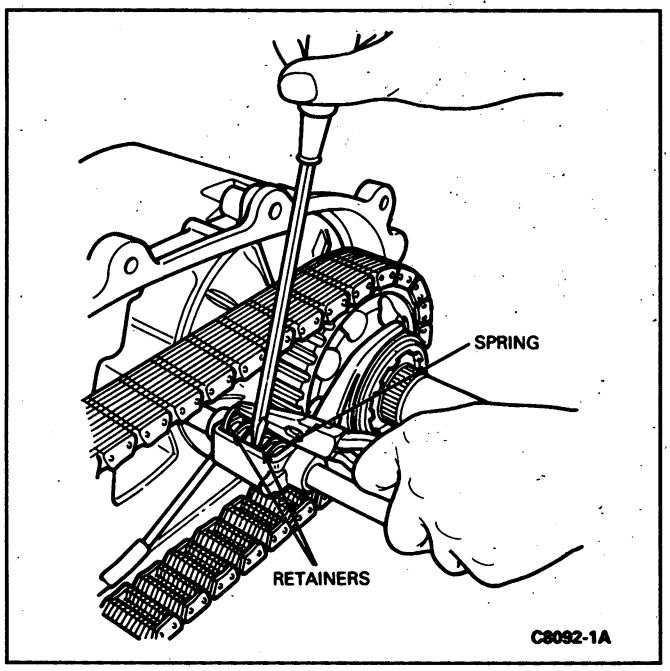


FIG. 7 Removing Spring Retainers

20. With a drift, drive out the plug from the detent spring bore (Fig. 15).

Assembly

Before assembly, lubricate all parts with automatic transmission fluid, DEXRON® II, XT-2-QDX, (ESP-M2C138-CJ) or equivalent.

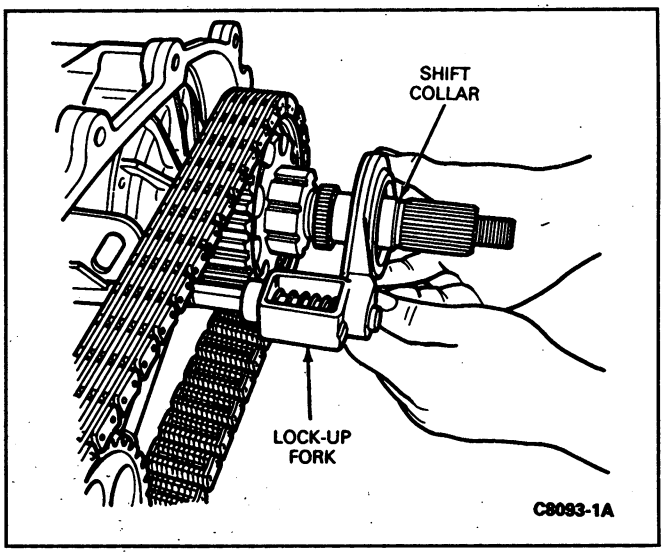


FIG. 8 Removing Lock-up Fork and Shift Collar

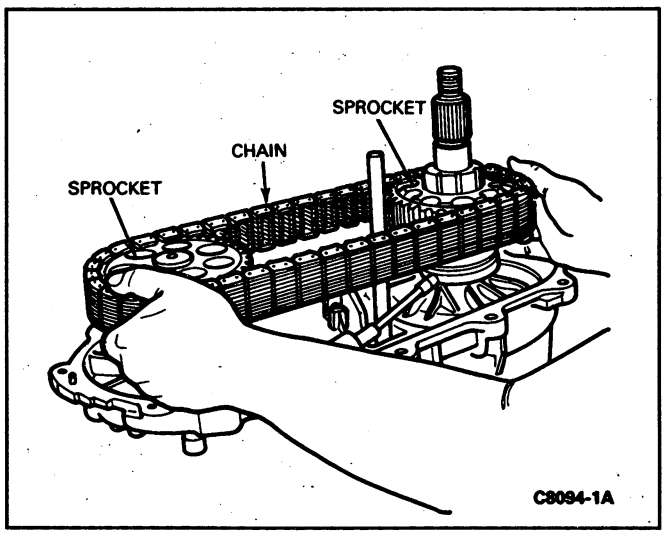


FIG. 9 Removing Sprockets and Chain

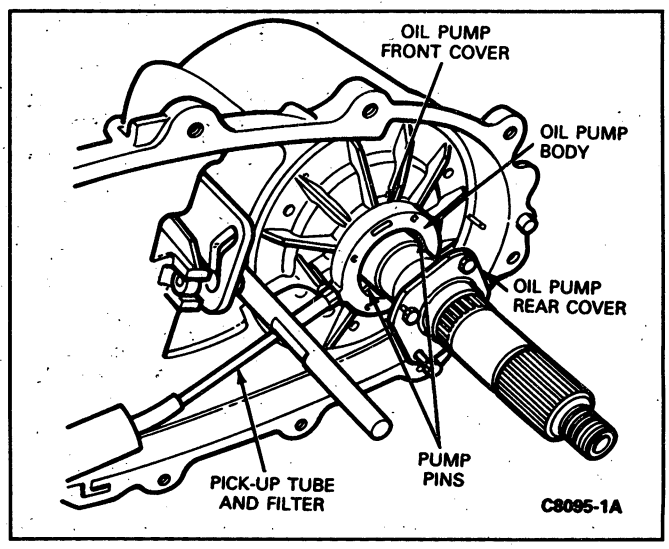


FIG. 10 Removing Oil Pump Assembly

1. Assemble the planetary gear set, shift rail, shift cam, input shaft and shift fork together as a unit

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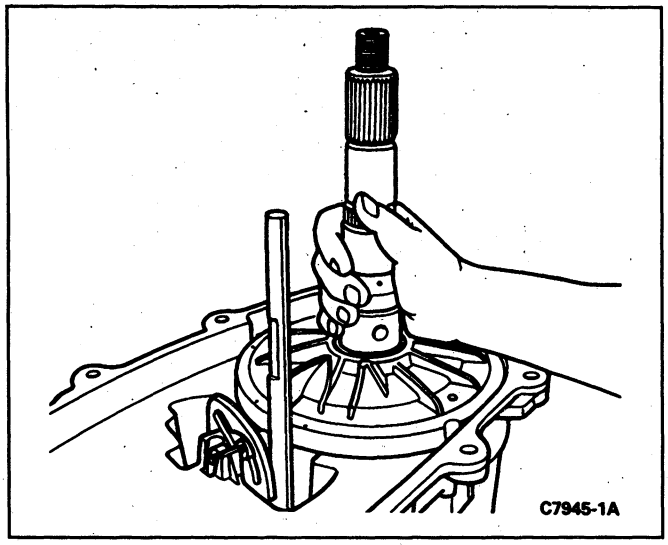


FIG. 11 Removing Rear Output Shaft

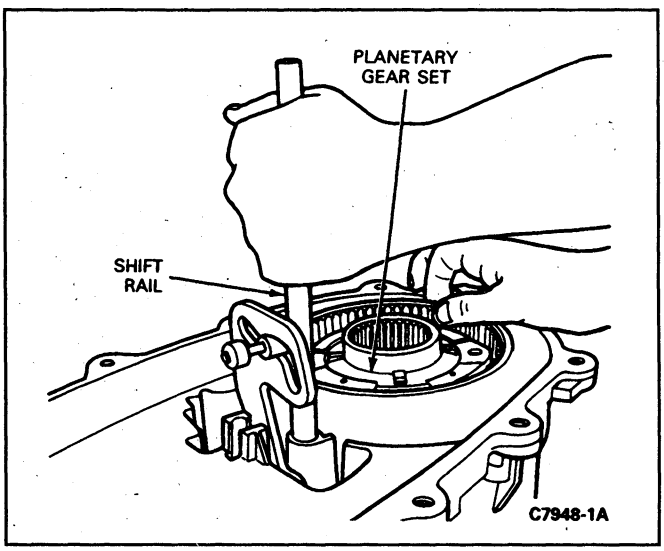


FIG. 13 Removing Shift Rail

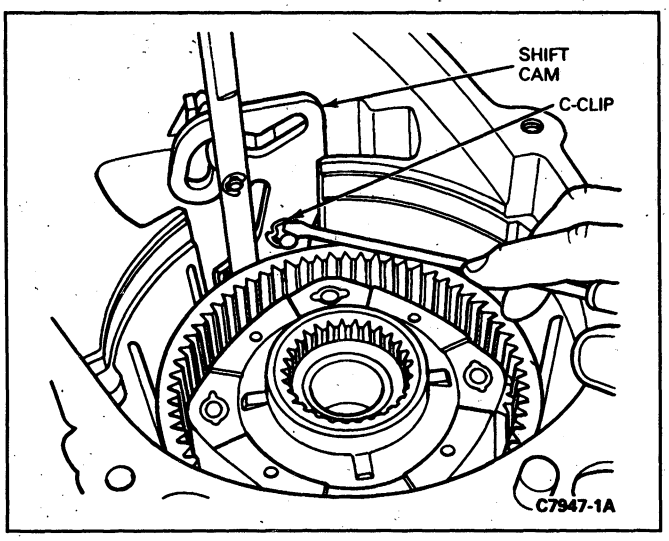


FIG. 12 Removing Shift Cam C-Clip

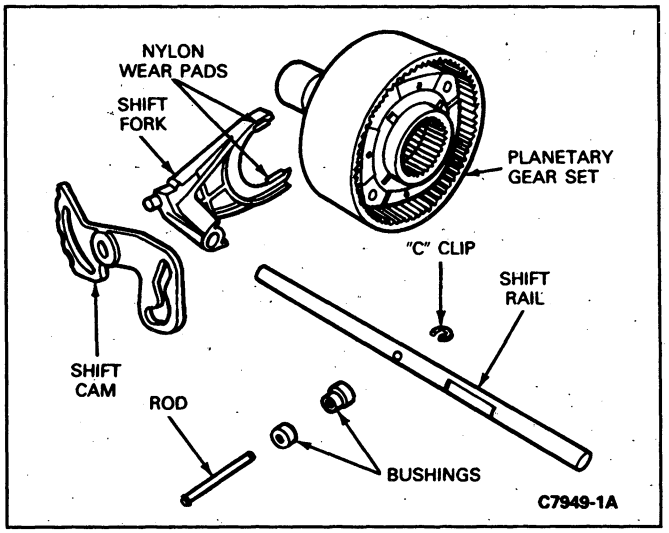


FIG. 14 Shifter Mechanisms

(Fig. 16). Make sure the boss on the shift cam is installed toward the case. Install the spacer washer on the input shaft.

2. Place the rear output shaft in the planetary gear set, making sure the shift cam engages the shift fork actuating pin (Fig. 17).
3. Lay the case on its side. Insert the rear output shaft and planetary gear set into the case. Make sure the spacer washer remains on the input shaft.
4. Install the shift rail into the hole in the case. Install the outer roller bushing into the guide in the case.
5. Remove the rear output shaft and position the shift fork in neutral (Fig. 17).
6. Place the shift control lever shaft through the cam, and install the clip ring. Make sure the shift control lever is pointed downward and is parallel to the front face of the case to be in the neutral position (Fig. 18).
7. Check shift fork and planetary gear engagement. Unit should operate freely without any binding.
8. If removed during disassembly, press new needle bearing into the bearing retainer using Output Bearing Replacer—Rear, T80T-7127-C.
9. Insert output shaft through the bearing retainer from the bottom side outward.
10. Insert the rear output shaft pilot into the input shaft rear bushing. Align the dowel holes and lower the bearing into position.
11. Install dowel pins. Install snap ring that retains the bearing retainer in case.
12. Insert detent ball and spring in detent bore in case half (Fig. 19). Coat the seal plug with RTV sealant or equivalent. Drive plug into case until the lip of the plug is 0.79mm (1/32 inch) below the surface of the case. Peen the case over the plug in two places.
13. Install the oil pump front cover over the output shaft with the flanged side down. The word "Top" must be facing the top of the transfer case as the position the case is installed in the vehicle.
14. Install the oil pump spring and two pump pins with the flat side outward in the hole in the output shaft.

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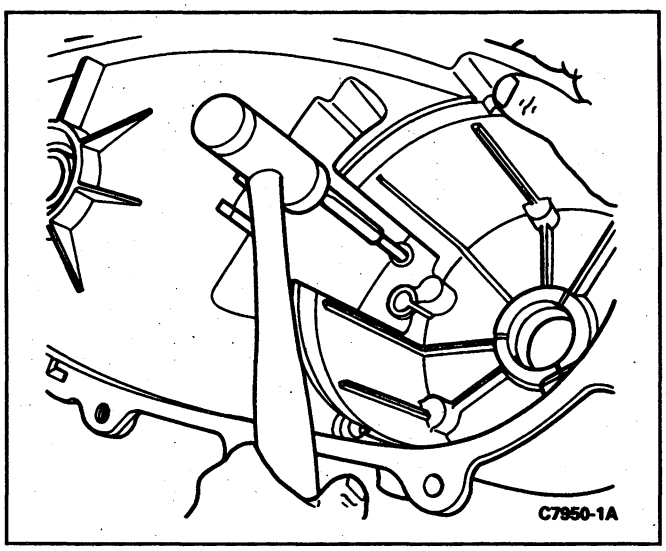


FIG. 15 Removing Detent Ball Plug

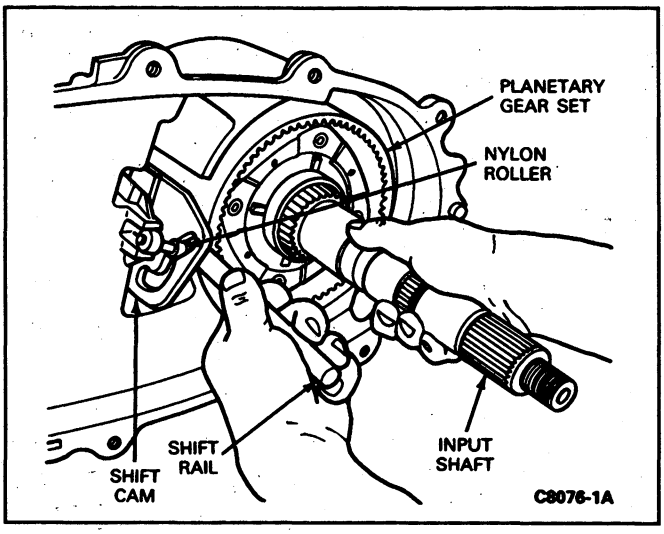


FIG. 16 Installing Planetary Gear Set and Shifter Mechanism

Push in both pins to install the oil pump body, pickup tube and filter. (The 'REAR' markings on the pump body must face upward). Prime the pump with automatic transmission fluid, DEXRON® II, XT-2-QDX (ESP-M2C138-CJ) or equivalent.

15. Place the oil pump rear cover on the output shaft with the flanged side outward. The word "Top Rear" is positioned toward the top of the transfer case in the position the transfer case is installed in the vehicle. Apply Loctite or equivalent to oil pump bolts and install in pump cover. Tighten to 4.0-4.5 N·m (36-40 in-lb) and rotate the pump while tightening.

    NOTE: When the oil pump is correctly installed, it will rotate freely on the output shaft.

16. Install the thrust washer on the rear output shaft next to the oil pump.

17. Install chain on drive sprocket and driven sprocket. Lower the chain and sprockets into position in the case. The driven sprocket is installed over the front output shaft and the drive sprocket is placed on the rear output shaft.

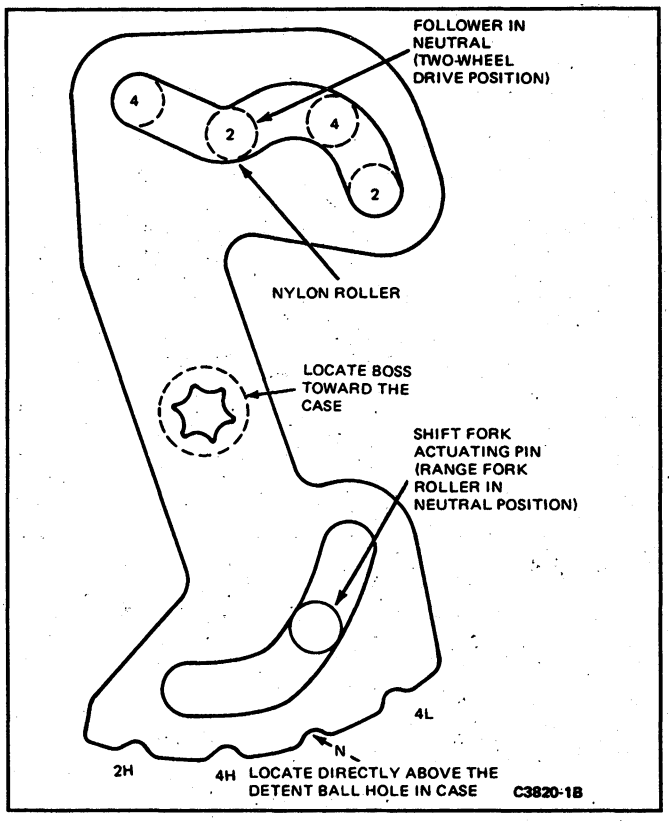


FIG. 17 Correct Shift Cam Engagement

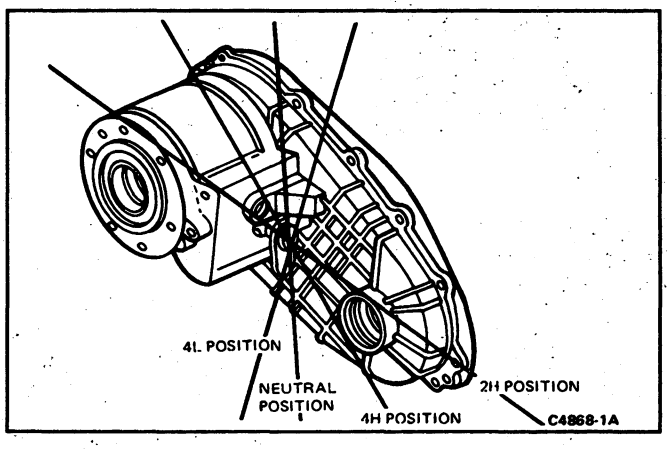


FIG. 18 Correct Shift Lever Installation

18. Assemble the washer and snap ring behind the driven sprocket.

19. Engage the four-wheel drive shift fork on the shift collar. Slide the shift fork over the shift shaft and the shift collar over the rear output shaft. Make sure the nylon wear pads are installed on the shift fork tips and that the necked down part of the shift collar is facing rearward. Note that the location holes in the nylon wear pad and lockup fork are assembled correctly.

20. Push the four-wheel drive shift spring downward and install the upper spring retainer. Push the spring upward and install the lower retainer.

21. Install the shift collar hub on the rear output shaft.

22. Apply a bead of RTV sealant, Silicone Rubber, D6AZ-19562-A (ESB-M4G92-A), or Rotunda Gasket Compound #071-00002, or equivalent on

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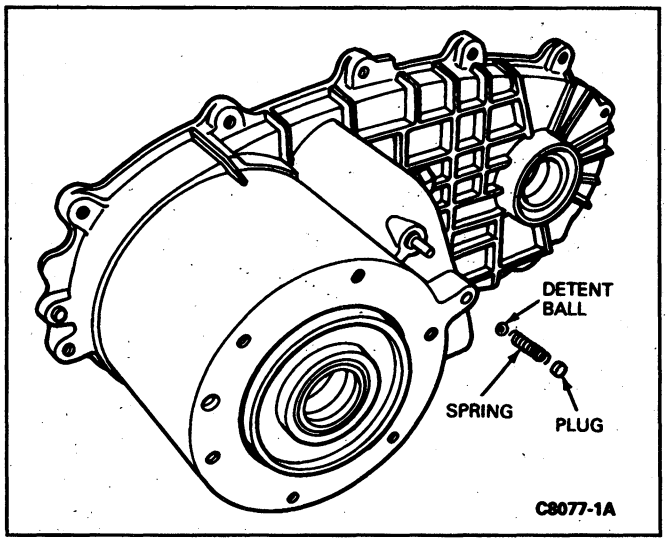


FIG. 19 Installing Detent Ball

the case mounting surface. Lower the cover over the rear output shaft. Align the shift rail to its blind hole in cover. Make sure the front output shaft is fully seated in its support bearing. Install attaching bolts and tighten to 55-61 N·m (40-45 ft. lb). Allow one hour curing time for gasket material prior to operating vehicle.

23. Install the four-wheel drive indicator switch. Tighten to 11-16 N·m (8-12 ft. lbs).
24. Press an oil slinger on the front yoke. Install front and rear output shaft yokes. Install the anti-spill oil seal. Coat the face of the yoke nuts and output shaft threads with Threadlock and Sealer, E0AZ-19554-A (ESE-M4G204-A) (Type II) or equivalent and tighten to 136-176 N·m (100-130 ft. lb). Install the speedometer assembly.
25. Refill transfer case with 3.1 liters (6.5 pints) of automatic transmission fluid, DEXRON® II, XT-2-QDX (ESP-M2C138-CJ), or equivalent. Tighten level and drain plugs to 9-18 N·m (6-14 ft. lb). Tighten fill plug to 21-33 N·m (15-25 ft. lb).
26. Install transfer case in vehicle as described in this Section.
27. Start engine and check transfer case for correct operation. Stop engine and check fluid level. Fluid should drip from level hole. If fluid flows out level hole in a stream, the pump may not be operating properly.

Planetary Gear Set

Disassembly

1. Slide the input shaft rearward out of the planetary gear set (Fig. 20).
2. Remove the snap ring from the annulus gear. Remove the shift hub and planetary gear case from the annulus gear.
3. Unlock the two (2) locking plates (Fig. 21) from the hub. Remove the shift hub snap ring and "T" shaped lock key. Lift the shift hub from the assembly (Fig. 22).
4. Remove the outer fiber washer, sun gear and inner fiber washer (Fig. 22). Rotate inner fiber washer slightly upon removal to allow positioning tabs to clear planetary gears. Replace fiber washers upon assembly.

Assembly

1. Place a new inner fiber washer into the planetary gear housing.
2. Install sun gear.
3. Coat new outer fiber washer with vaseline or equivalent. Install outer washer on hub.
4. Place hub in planetary gear cage and install "T" shape lock key and snap ring.
5. Install ring gear plate, with dished side toward the planetary gear set, on the shift hub.
6. Lower the planetary assembly into the annulus gear. Be sure the tabs on the locking plate engage the annulus gear teeth. Install snap ring.

Cover

Disassembly

1. Remove snap ring retaining the rear output shaft ball bearing assembly in the cover.
2. Turn cover over and remove the rear output shaft seal with T50T-100-A, Slide Hammer, and Tool 1175-AC, seal remover (Fig. 23).
3. Remove speedometer drive gear.
4. Press the rear output shaft ball bearing out from the cover.
5. Remove speedometer gear adapter.
6. Remove front output shaft inner needle bearing from cover with T50T-100-A, Slide Hammer, and D80L-100-T, Collet from D80L-100-A, Blind Hole Puller Set (Fig. 24).

Assembly

1. Press a new needle bearing into the cover using output Bearing Replacer—Front, T80T-7127-B.
2. Press a new ball bearing assembly into the cover. Install snap ring.
3. Turn cover over and install speedometer drive gear.
4. Install new output shaft seal into position.
5. Install speedometer gear adapter.

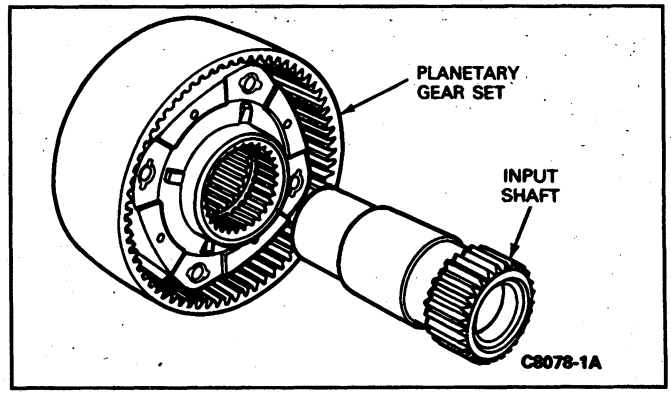


FIG. 20 Removing Input Shaft From Planetary Gear Set

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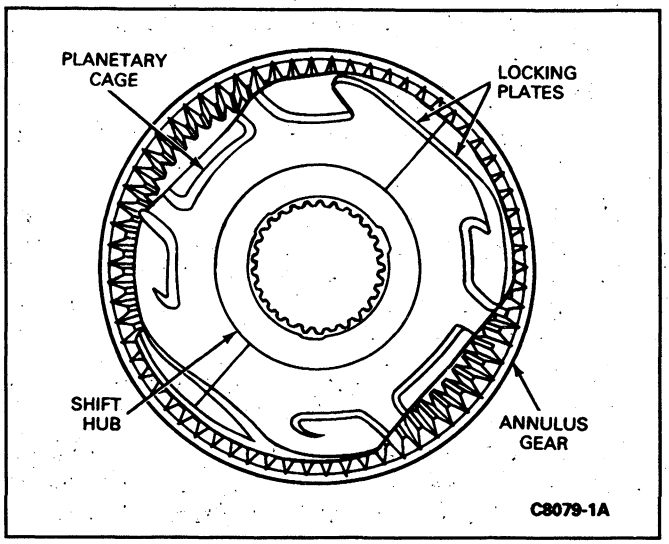


FIG. 21 Lock Plate Removal

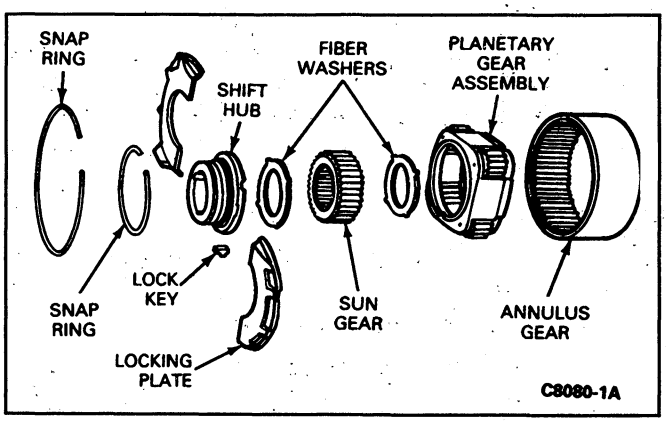


FIG. 22 Planetary Gear Set

Case

Disassembly

1. Remove snap ring retaining front output shaft ball bearing assembly in case.
2. Remove output shaft seal and both input shaft seals.
3. Press the front output shaft bearing and input shaft bushing from the case.

Assembly

1. Press new input shaft bushing into case. Make sure lug is in downward position.
2. Install new output shaft ball bearing. Install snap ring.

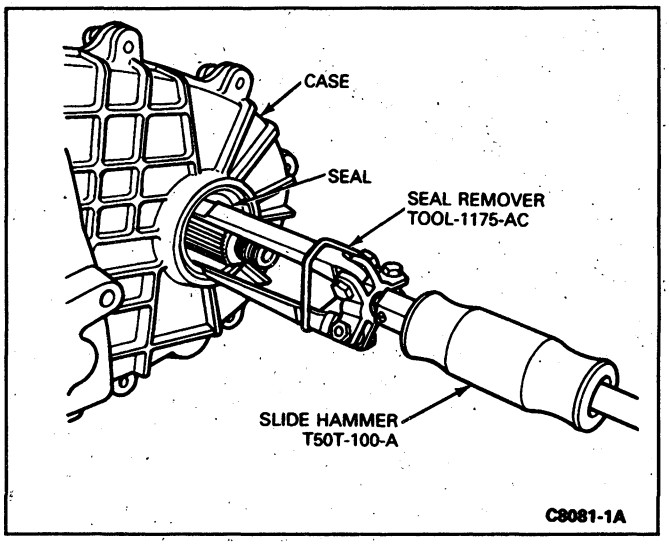


FIG. 23 Removing Front Output Shaft Seal From Case

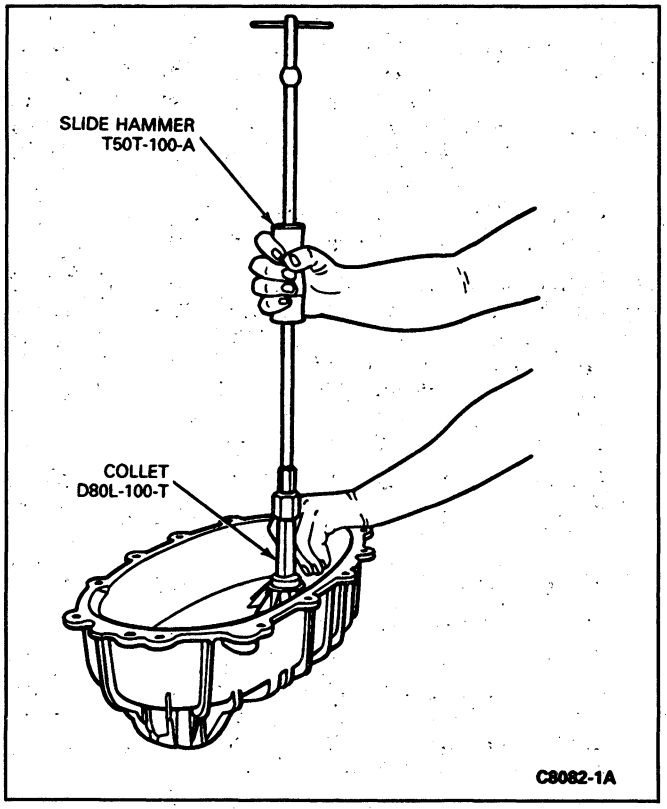


FIG. 24 Removing Needle Bearing

3. Press both input shaft seals into case.
4. Press front output shaft seal into case.

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 lb.	Universal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-T	Blind Hole Puller	Universal 1-1/4" to 1-1/2"
D80L-100-H	Actuator Pin	Use with Blind Hole Puller
TOOL-1175-AC	Seal Remover	Universal — Use with Impact Slide Hammer
T80T-7127-B	Output Bearing Replacer — Front	Borg Warner #1345 Transfer Case
T80T-7127-C	Output Bearing Replacer — Rear	Borg Warner #1345 Transfer Case

CC4011-2C

TORQUE SPECIFICATIONS — BORG WARNER 1345 TRANSFER CASE

Description	Torque Limits	
	N-m	Ft-Lbs
Case Half Attaching Bolts	48-54	35-40
Four Wheel Drive Indicator Switch	34-47	25-35
Front and Rear Output Yokes to Transfer Case	163-203	120-150
Drain Plug	19-30	14-22
Fill Plug	19-30	14-22
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke	163-203	120-150
Rear Driveshaft to Rear Output Yoke	163-203	120-150
Rear Driveshaft to Rear Output Yoke-Nut-F150-F350 4x4	11-20	8-15

CC4012-2E

ROTUNDA EQUIPMENT

Number	Description
077-00019	Transmission Jack
071-00002	Gasket Compound

CC7406-1B

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GROUP 17 AUTOMATIC TRANSMISSION

SECTION TITLE	PAGE
AUTOMATIC OVERDRIVE TRANSMISSION	17-20-1
C6 AUTOMATIC TRANSMISSION	17-10-1
E4OD AUTOMATIC TRANSMISSION	17-09-1
GENERAL AUTOMATIC TRANSMISSION SERVICE	17-01-1
SHIFT CONTROL LINKAGE	17-02-1

SECTION 17-01 General Automatic Transmission Service

SUBJECT	PAGE
CLEANING AND INSPECTION	
Case	17-01-35
Control Valve Body	17-01-24
Converter and Fluid Cooler	17-01-32
Converter Damper/Hub Weld Check—AOD Only	17-01-33
Converter End Play and One Way Clutch Check	17-01-32
Direct Clutch—AOD	17-01-31
Direct Clutch Piston Check Ball Leakage Procedure	17-01-31
Extension Housing	17-01-29
Forward Clutch	17-01-31
Front Pump	17-01-29
Governor	17-01-29
Intermediate Clutch—AOD	17-01-32
Intermediate Servo	17-01-25
C6	17-01-25
Low—Reverse Clutch—C6	17-01-31
Low-Reverse Servo	17-01-25
AOD	17-01-25
Overdrive Servo	17-01-29
AOD	17-01-29
Pinion Carriers	17-01-34
C6 and AOD	17-01-34
Planet Carrier and Center Support (AOD)	17-01-32
Planetary One-Way Clutch	17-01-32
Reverse-High Clutch—C6—Reverse Clutch—AOD	17-01-31
Stator Support	17-01-35
C6 and AOD	17-01-35
Stator to Impeller Interference Check	17-01-34
CLEANING AND INSPECTION (Cont'd)	
Stator to Turbine Interference Check—C6 and AOD Converters	17-01-34
Transmission	17-01-24
DIAGNOSIS AND TESTING	
Air Pressure Checks	17-01-14
C6	17-01-14
Forward Clutch	17-01-14
Governor	17-01-14
Intermediate Servo	17-01-14
Low-Reverse Clutch C6 Only	17-01-14
Reverse-High Clutch	17-01-14
Air Pressure Checks AOD	17-01-14
Control Pressure Test	17-01-6
C6	17-01-6
Control Pressure Test—AOD	17-01-7
Converter Leakage Check	17-01-6
Diagnosis Guides	17-01-17
Direct Clutch Pressure Test—AOD	17-01-9
Engine Idle Speed Check	17-01-6
Engine Vacuum Pressure	17-01-6
Fluid Leakage in Converter Area	17-01-5
Governor Check	17-01-9
AOD	17-01-10
C6	17-01-9
High or Low Fluid Level	17-01-4
Linkage Check	17-01-2
4.9L (300 CID) I-6 and 5.0L EFI Engine Application	17-01-2
Accelerator Linkage and Operation	17-01-2
Kickdown Linkage—C6 Transmission	17-01-2
Manual Linkage	17-01-3
Throttle Valve Control Cable System Check—AOD	17-01-2

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SUBJECT	PAGE
DIAGNOSIS AND TESTING (Cont'd)	
Shift Point Checks	17-01-10
C6	17-01-10
Road Test	17-01-10
Shift Point Checks AOD	17-01-11
In Shop	17-01-13
Road Test	17-01-11
Stall Test	17-01-9
Transmission Fluid Condition Check	17-01-3
Transmission Fluid Cooler Flow Check	17-01-4
Transmission Fluid Leakage Checks	17-01-4
Transmission Fluid Level Check	17-01-3
Vacuum Diaphragm Test—Off Vehicle	17-01-7
C6	17-01-7
Vacuum Diaphragm Test—On Vehicle	17-01-7
C6	17-01-7
DIAGNOSIS AND TESTING (Cont'd)	
Vacuum Pump Method	17-01-7
C6	17-01-7
Vacuum Supply Test	17-01-7
C6	17-01-7
GENERAL INFORMATION	
Transmission Identification	17-01-2
REMOVAL AND INSTALLATION	
Fluid Cooler Lines	17-01-24
Transmission Fluid Drain and Refill	17-01-18
AOD Transmissions	17-01-21
C6 Transmissions	17-01-19
Vacuum Diaphragm C6	17-01-18
SPECIFICATIONS	17-01-36
VEHICLE APPLICATION	17-01-2

VEHICLE APPLICATION

Applies to all E-150—E-350, F-150—F-350 (4x2) (4x4) and Bronco Vehicles equipped with C6 and AOD Automatic Transmissions.

NOTE: For information on E4OD automatic transmissions, see Section 17-09, E4OD Automatic Transmission.

GENERAL INFORMATION

All automatic transmissions are equipped with high temperature resistant seals. This includes those seals used on the manual and kickdown levers, the O-rings and oil pan gasket. Under no conditions should older design seals be used on the transmissions, except the regular service replacement oil pan gasket, which is of special leak prevention design. This should still be used.

Transmission Identification

All vehicles are equipped with a Vehicle Safety Certification Label affixed to the left (driver's) side door lock post. Refer to the stamped code in the space marked "Trans." and to Fig. 1 below for proper transmission identification. Refer to Section 10-00, Identification Codes for specific transmission identification coding.

DIAGNOSIS AND TESTING

Troubleshooting the automatic transmission is simplified by using the proven methods of diagnosis. One of the most important things to remember is that there is a definite procedure to follow. Do not try to short cut or take it for granted that someone else has done the critical checks or adjustments.

The following procedures are recommended for checking and/or verifying that the various components are adjusted and operating properly. If an Automatic Transmission Tester is used, Rotunda model 014-00737 or equivalent, follow the manufacturer's instructions.

Linkage Check

Accelerator Linkage and Operation

The linkage must be free and must return to idle when released. Refer to Section 24-60—Carburetor Throttle Linkage for accelerator linkage adjustment and to the Engine/Emissions Diagnosis Manual for dashpot adjustment.

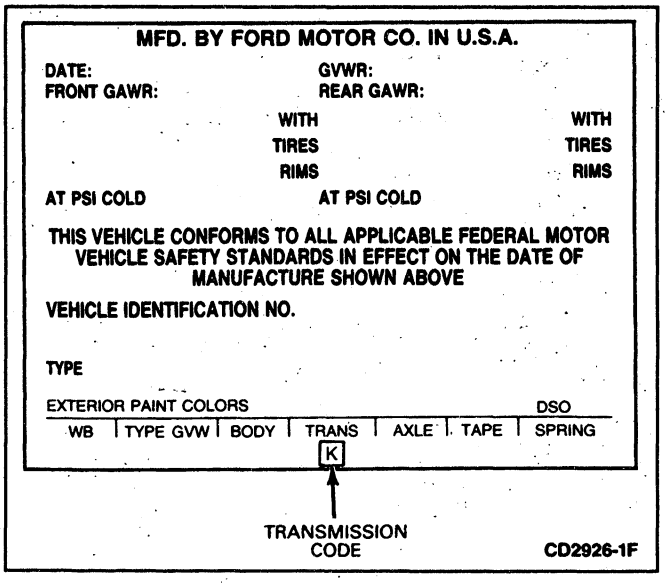


FIG. 1 Typical Vehicle Safety Standard Certification Label—Transmission Identification

Kickdown Linkage—C6 Transmission

Check for wide-open carburetor and linkage travel at full throttle. The carburetor full-throttle stop must be contacted by the throttle linkage and there must be a slight amount of movement left in the downshift linkage. Be sure the downshift linkage return spring is connected and the downshift lever returns to a closed position.

For carburetor and EFI system kickdown linkage procedures, refer to Section 24-60, Throttle Linkage.

Throttle Valve Control Cable System Check—AOD

4.9L (300 CID) I-6 and 5.0L EFI Engine Application

Check for free cable and lever travel and return between idle and wide open throttle. Cable must not be loose where it fastens to the throttle body lever.

CAUTION: Do not drive vehicle if cable is broken or disconnected at carburetor.

Damage to friction elements in the transmission may result due to excessive slipping since TV (Throttle Valve) pressure will remain near zero. If it is necessary

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to drive truck before repairing or resetting cable, disconnect cable at the transmission lever. TV pressure will now be near maximum allowing light throttle operation. However, shifts will be delayed and harsh.

Refer to Section 17-20, Automatic Overdrive Transmission for adjustment of automatic overdrive TV cable linkage.

Manual Linkage

This is a CRITICAL adjustment. Be sure the "D" (C6) or Ⓓ (AOD) detent in the transmission corresponds exactly with the stop in the steering column or console. Hydraulic leakage at the manual valve can cause delay in engagements and/or slipping while operating if the linkage is not correctly adjusted.

Transmission Fluid Level Check

CAUTION: Vehicle should not be driven if fluid level is below the "DO NOT DRIVE" hole.

Transmission—Operating Temperature

The automatic transmission should be checked at an operating temperature of 66 degrees to 77 degrees C (150 degrees to 170 degrees F) (dipstick is hot to the touch). The operating temperature may be obtained by driving 24-32 km (15 to 20 miles) of city-type driving with the outside temperature above 10 degrees C (50 degrees F).

CAUTION: If vehicle has been operated for an extended period at high speed, or in city traffic in hot weather, or vehicle is being used to pull a trailer, to obtain an accurate reading, the fluid has to cool, usually about 30 minutes after engine has been turned off.

Transmission—Room Temperature

If the transmission is not at an operating temperature of 66 degrees to 77 degrees C (150 degrees to 170 degrees F) and it becomes necessary to check the fluid level (such as pre-delivery), the fluid may be checked at room temperature, 21 degrees to 35 degrees C (70 degrees to 95 degrees F) (dipstick cool to touch).

Dipstick Reading

Refer to Fig. 2.

The fluid level on the dipstick should be within the cross hatched area at operating temperature. The fluid level on the dipstick should read between the holes at room temperatures.

Check the fluid as follows:

NOTE: It may be necessary to remove the air inlet tube located directly in the way of access to the dipstick.

1. With the transmission in PARK, engine at idle rpm, foot brakes applied, and vehicle on level surface, move the transmission/selector lever through each range, allowing time in each range to engage transmission. Return to PARK, applying parking brake fully, and block the wheels. Do not turn off the *engine during* the fluid level check.
2. Clean all dirt from the transmission fluid dipstick cap before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push it all the way back into the tube. Be sure it is fully seated.
4. Pull the dipstick out of the filler tube again, and check the fluid level.

IMPORTANT: The fluid level indication on the dipstick will be different at operating temperature and room temperature. For the correct fluid level reading on the dipstick, follow the appropriate instructions stated previously.

Before adding fluid, be sure that the correct type will be used. If in doubt, check the Vehicle Certification Label affixed to the left front door lock face panel or door pillar for the Transmission/Transaxle Code. Also, the fluid is stamped on the dipstick.

CAUTION: Use of a fluid other than specified could result in transmission malfunction and/or failure.

If necessary, add enough fluid through the filler tube to raise the level to the correct position. Do not overfill the transmission, because it will result in foaming, loss of fluid through the vent, and possible transmission malfunction. If overfill occurs, excess must be removed.

5. Install the dipstick, making sure it is fully seated in the tube.

If the transmission fluid level is correctly established at 21 degrees to 35 degrees C (70 degrees to 95 degrees F), it will appear in the cross hatch area on the dipstick when the transmission reaches an operating temperature of 66 degrees to 77 degrees C (150 degrees to 170 degrees F). Do not overfill or underfill.

Overfill can cause the fluid to foam and spill out through the transmission vent resulting in a transmission malfunction.

Underfill can result in transmission loss of engagement or slipping. This condition is most evident in cold weather or when the vehicle is parked or being driven on a hill.

If the transmission fluid level is checked when the fluid is at room temperature, the dipstick could indicate that fluid should be added if the dipstick is misread. If fluid is added at this time, an overfill condition could result when the fluid reaches operating temperatures of 66 degrees to 77 degrees C (150 degrees to 170 degrees F) (dipstick hot to touch).

Refer to the specifications at the end of this Section for automatic transmission fluid requirements and capacities.

Transmission Fluid Condition Check

1. Make the normal fluid check according to the above procedure.

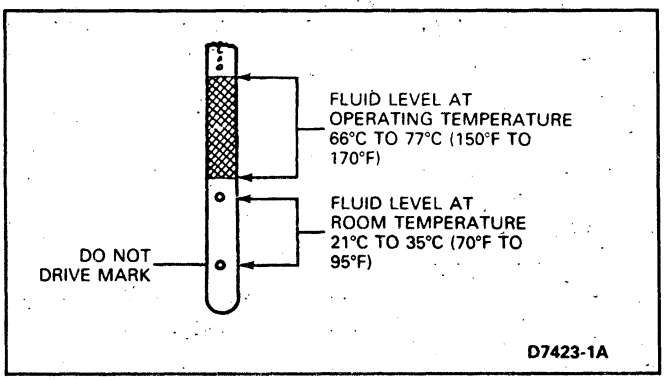


FIG. 2. Dipstick Reading—AOD, C6

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2. Observe color and odor of the fluid. It should be dark reddish not brown or black. A burnt odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.
3. Use an absorbent white facial tissue paper to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

   NOTE: Fluid used with the automatic transmission contains a detergent which retains in suspension particles generated during normal transmission use. This characteristic may result in a dark coloring of the fluid and does not by itself indicate malfunction or need for repair.

   If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and repaired. This includes cleaning the torque converter and transmission cooling system. It would be a waste of time to perform any further checks before cleaning and repairing the transmission.

   During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made.

High or Low Fluid Level

A fluid level that is too high will cause the fluid to become aerated. Aerated fluid will cause low control pressure, and the aerated fluid may be forced out the vent.

A fluid level that is too low can affect the operation of the transmission. Low level may indicate fluid leaks that could cause transmission damage.

Fluid Level High Before Starting Engine—OK During Normal Check

1. Check for correct operation of drainback valve in stator support.
2. Check pump bushing.
3. Replace or repair pump if required.

Transmission Fluid Cooler Flow Check

The linkage, fluid level and control pressure must be within specifications before performing this flow check.

Remove the transmission dipstick from the filler tube. Place a funnel in the transmission filler tube. Raise the vehicle, remove the cooler return line from its fitting in the case. Attach a hose to the cooler return line and fasten the free end of the hose in the funnel installed in the filler tube.

Start the engine and set idle speed at 1000 rpm with the transmission in neutral.

Observe the fluid flow at the funnel. When the flow is "solid" (air bleeding has been completed), the flow should be liberal. If there is not a liberal flow at 1000 rpm in neutral, low pump capacity, main circuit system leakage, or cooler system restriction is indicated.

Check both metal cooler lines between the transmission and radiator for restrictions. Check for restrictions in the metal or rubber cooler lines to and from the auxiliary cooler, if the vehicle is so equipped. Visually check and physically feel all bends for kinks, especially rubber cooler lines, that would restrict flow and could result in transmission overheating or lack of lubrication.

To separate transmission trouble from cooler system trouble, observe the flow at the transmission case converter-out fitting.

Transmission Fluid Leakage Checks

Check the speedometer cable connection at the transmission. Replace the rubber seal if necessary (if so equipped).

Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to the proper torque. If necessary, replace the gasket.

Check the fluid filler tube connection at the transmission case. If leakage is found, install a new O-ring. The filler tube brackets should align properly and be attached to the transmission or engine locations.

Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage is found, tighten the fitting, or replace the damaged parts (Fig. 3).

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying 345-517 kPa (50-75 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure build up at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, the cooler must be replaced. Cooler replacement is described in the Cooling System Section of Group 27.

If leakage is found at either the downshift control lever shaft or the manual lever shaft, replace either or both seals.

Inspect the pipe plug on the left front side of the transmission case. If the plug shows leakage, tighten the plug to specifications. If leakage continues, replace the plug. On a C6 transmission, inspect the TV pressure plug on the right rear side of the case. On the AOD transmission, inspect the TV pressure plug, forward clutch, pressure plug and direct clutch on the right side of the case and tighten to specification if leakage is

Transmission	Radiator		Transmission		Fluid Line Nut	
	ft-lbs	N·m	ft-lbs	N·m	ft-lbs	N·m
AOD	8-12	11-16	18-23	24-31	12-18	17-24
C6	8-12	11-16	18-23	24-31	12-18	17-24

CD3141-2D

FIG. 3 Cooler Line Fitting Torque Specifications

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evident. If the plug shows leakage, coat the threads with Motorcraft Sealing Compound or equivalent and tighten the plug to specification as listed at the end of the appropriate transmission Section. If leakage continues, replace the plug.

When a converter drain plug leaks, remove the drain plug with a six-point wrench. Coat the threads with Motorcraft Sealing Compound or equivalent and install the plug. Tighten the drain plug to specification as listed at the end of this Section. **Fluid leakage from the converter housing may also be caused by engine oil leaking past the rear main bearing, or from oil galley plugs, or power steering oil leakage from steering system. Be sure to determine the exact cause of the leak before starting repair procedures.**

Oil-soluble aniline or fluorescent dyes premixed at the rate of 1/2 teaspoon of dye powder to 0.23 liter (1/2 pint) of transmission fluid have proved helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

Fluid Leakage in Converter Area

In diagnosing and correcting fluid leaks in the front pump and converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of transmission, is evidenced by fluid around the converter housing, may have several sources. By careful observation, it is possible in many instances, to pinpoint the source of the leak before removing the transmission from the vehicle. The paths which the fluid takes to reach the bottom of the converter housing are shown in (Fig. 4).

1. Fluid leaking by the front pump seal lip will tend to move along the drive hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.
2. Fluid leakage by the outside diameter of the seal and front pump body will follow the same path which the leaks by the front pump seal follow.
3. Fluid that leaks by a front pump-to-case bolt will be deposited on the inside of the converter housing only. Fluid will not be deposited on the back of the converter.
4. Leakage by the front pump-to-case gasket may cause fluid to be deposited inside the converter housing, or it may seep down between the front of the case and converter housing.
5. Fluid leakage from the converter drain plugs or converter-to-flywheel stud weld will appear at the outside diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel.

Engine oil leaks are sometimes improperly diagnosed as transmission front pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the problem:

a. Leakage at the rocker arm cover (valley cover) may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block, causing oil to be present in or at the bottom of the converter housing.

b. Oil galley plug leaks will allow oil to flow down the rear face of the block to the bottom of the converter housing.

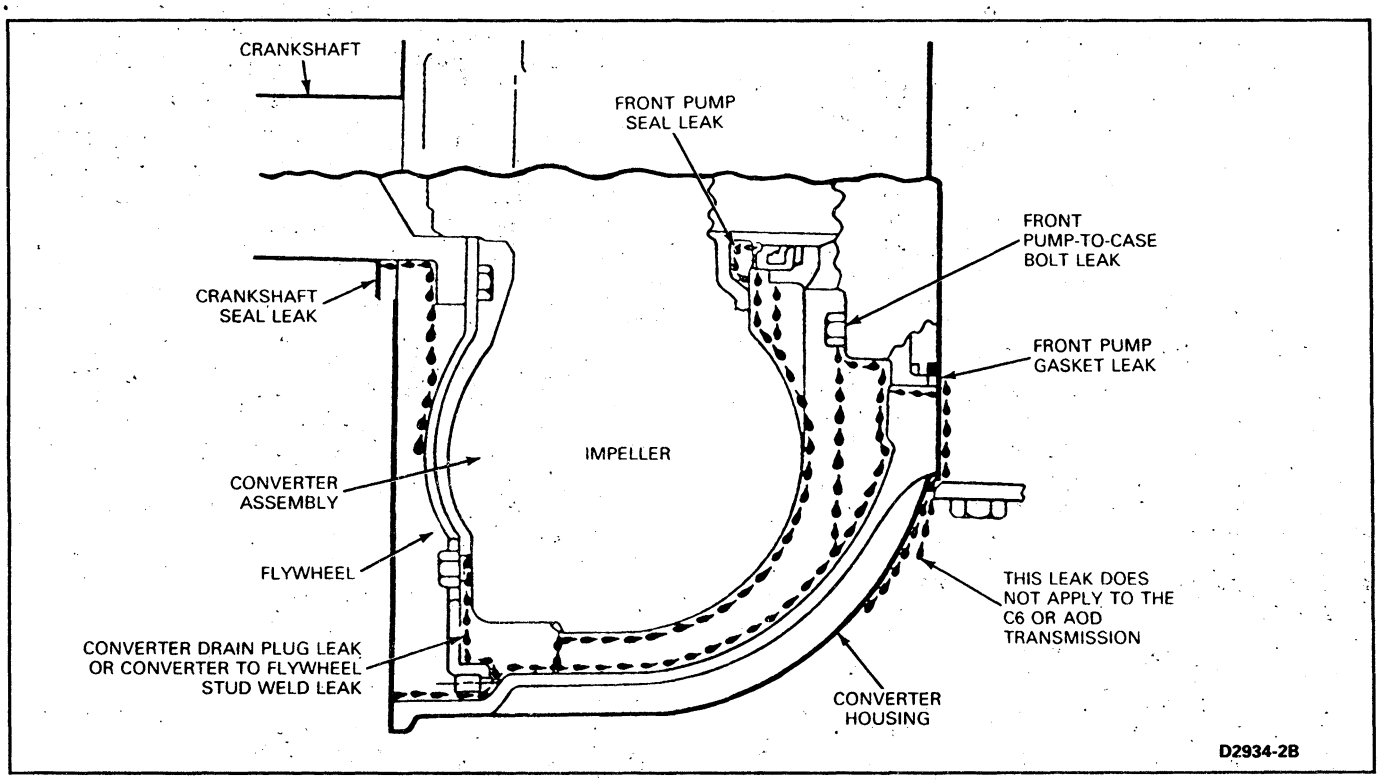


FIG. 4 Converter Leakage—Fluid Path

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c. Leakage by the crankshaft seal will work back to the flywheel, and then into the converter housing.

Fluid leakage from other areas, such as the power steering system forward of the transmission, could cause fluid to be present around the converter housing due to blow back or road draft. The following procedures should be used to determine the cause of the leakage before any repairs are made.

a. Remove the transmission dipstick and note the color of the fluid. Original factory-fill fluid is dyed red, to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the color should assist in pinpointing the leak. Since road draft may cause leaking power steering fluid to be present on the transmission, this leakage, if present, should be eliminated before checking the transmission for fluid leakage.

b. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and engine oil pan. Clean the converter area by washing with a suitable non-flammable solvent, and blow dry with compressed air.

c. Wash out the converter housing, the front of the flywheel, and the converter drain plugs. The converter housing may be washed out using cleaning solvent and a squirt-type oil can. Blow all washed areas dry with compressed air.

d. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and run the engine at fast idle, then at engine idle, occasionally shifting to the drive and reverse ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Converter Leakage Check

If welds on the torque converter indicate leakage, remove the converter and make the following check.

Assemble a Rotunda 021-00054 Torque Converter Leak Detector or an equivalent to the converter. Test the converter for leaks following the directions supplied with the detector kit.

Engine Idle Speed Check (With the Throttle Positioner Application)

On vehicles that have curb idle speed adjustment capability, if the idle speed is too low, the engine will run roughly. An idle speed that is too high will cause the vehicle to creep, have harsh engagements and harsh closed-throttle downshifts.

Refer to the ENGINE/EMISSION DIAGNOSIS* manual for curb idle speed adjustment information.

On vehicles equipped with an Exhaust Gas Recirculation (EGR) system, it is important to check the system for proper operation and for a no restricted or leakage condition.

Control Pressure Test

C6

There are two methods of performing the control pressure test. One is to perform the test using the engine vacuum. The second method is to use a remote vacuum source such as the one provided in the distributor tester or a hand operated vacuum pump.

Engine Vacuum Pressure

When the vacuum diaphragm unit is operating properly and the manual and downshift linkage is adjusted properly, all the transmission shifts (automatic and kickdown) should occur within the road speed limits listed in the Technical Service Bulletin—Special Specifications Issue.

If the shifts do not occur within limits, or the transmission slips during shift point, use the following procedure to determine whether the engine, transmission, linkage, vacuum diaphragm unit or valve body is causing the condition. See Section 17-10 for 7.3L Diesel C6 application for (VRV) Vacuum Regulator Valve.

1. Attach a tachometer to the engine and a vacuum gauge, Rotunda Number 059-00008, or equivalent to the transmission vacuum line at the manifold vacuum port (Fig. 5).
2. Attach a pressure gauge to the control pressure outlet at the transmission (Fig. 6).

   CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken NOT to accelerate or decelerate rapidly. Possible transmission failure could result.
3. Firmly apply the parking brake and start the engine.
4. Adjust the engine idle speed to the specified rpm, using the carburetor idle adjustment screw. If the

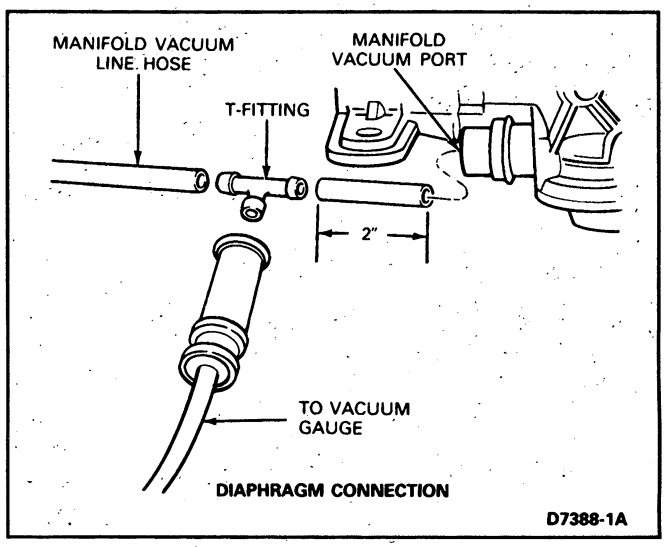


FIG. 5 Typical Vacuum Test Line Connections

*May be purchased as a separate item.

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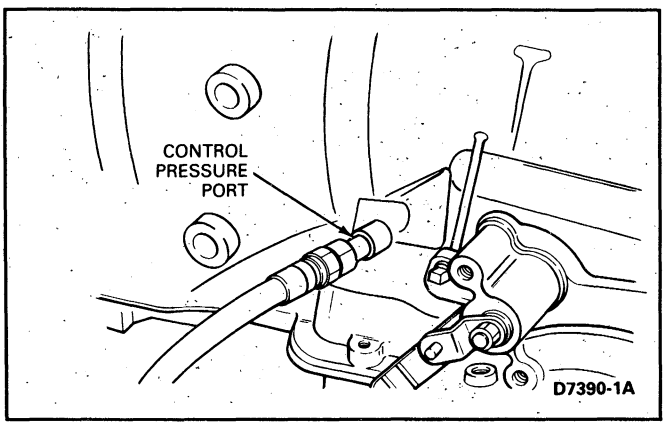


FIG. 6 Control Pressure Connecting Point—C6 Transmissions

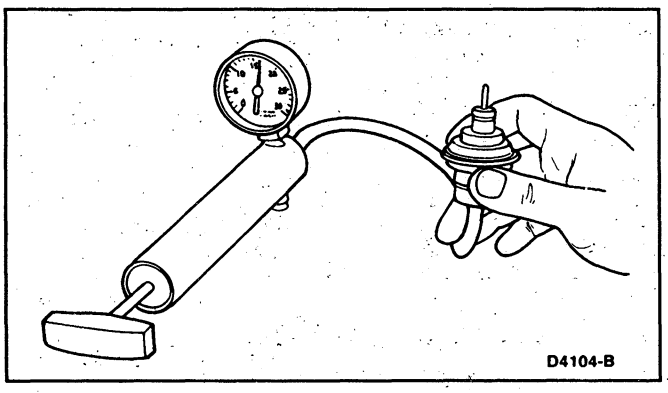


FIG. 7 Testing Transmission Vacuum Unit for Leakage

engine idle speed cannot be brought within limits, check the throttle and downshift linkage for a binding condition. If linkage is satisfactory, check for vacuum leaks in the transmission diaphragm unit (Fig. 7) and its connecting tubes and hoses. Check all other vacuum operated units (such as the power brake) for vacuum leaks. Refer to the appropriate brake Section in Group 12.

Refer to the two control pressure diagnostic guides in Fig. 8 to show what components are inoperative when the control pressure test is not within specifications. Do not proceed with the main diagnosis guide until you have made any repairs, as required, and the control pressure is within specifications as listed in the Technical Service Bulletin—Special Specifications Issue.

Vacuum Pump Method

C6

Disconnect and temporarily plug the vacuum line at the vacuum diaphragm unit. Attach a vacuum pump to the vacuum diaphragm. Apply both the parking and service brakes. Start the engine and vacuum pump. Set the vacuum at 15 inches, read and record the control pressure in all selector positions. Run the engine up to 1000 rpm, and reduce the vacuum to 10 inches. Read and record the control pressure in D, 2 and 1. Keep the engine rpm at 1000 and reduce the vacuum to 1 inch. Read and record the control pressure in D, 1, 2 and R.

Refer to the two control pressure diagnostic guides in Fig. 8 to show what components are inoperative when the control pressure test is not within specifications. Do not proceed with the main diagnosis guide until you have made any repairs, as required, and the control pressure is within specifications as listed in the Technical Service Bulletin—Special Specifications Issue.

Vacuum Supply Test

C6 (See Section 17-10 for 7.3L Diesel C6 Application for (VRV) Vacuum Regulator Valve)

The vacuum supply to the vacuum diaphragm unit and the diaphragm itself must be checked. To check the supply, disconnect the vacuum line at the diaphragm unit and connect it to a vacuum gauge. With the engine idling, the gauge must have a steady acceptable vacuum reading for the altitude at which the test is being performed. If the vacuum reading is low, check for a vacuum leak or poor engine vacuum. If the vacuum reading is OK, rapidly accelerate the engine momentarily. The vacuum reading must drop rapidly at acceleration and return immediately upon release of the accelerator. If the vacuum reading does not change or changes slowly, the transmission vacuum line is plugged, restricted or connected to a reservoir supply. Correct as required.

Vacuum Diaphragm Test—On Vehicle

C6

To check the vacuum diaphragm unit, start the vacuum pump and set the regulator knob so that the vacuum gauge reads 18 inches with the end of the vacuum hose blocked off. Then connect the vacuum hose to the diaphragm unit. If the gauge still reads 18 inches, the vacuum diaphragm unit is not leaking. If the reading does not remain at 18 inches, but drops, the vacuum diaphragm unit is leaking. Replace the vacuum diaphragm unit. Also, if automatic transmission fluid is present in the vacuum side of the diaphragm or in the vacuum hose, the diaphragm is leaking and must be replaced.

Vacuum Diaphragm Test—Off Vehicle

C6

To check the vacuum unit for diaphragm leakage, remove the unit from the transmission. Use a distributor tester equipped with a vacuum pump or Rotunda Vacuum Tester 021-00014 or equivalent (Fig. 7). Set the regulator knob until the vacuum gauge reads 18 inches with the end of the vacuum hose blocked off.

Connect the vacuum hose to the manifold vacuum port as shown in Fig. 7. If the gauge still reads 18 inches, the vacuum unit diaphragm is not leaking. A second leakage check can be made as the hose is removed from the transmission vacuum unit. Hold a finger over the end of the control rod. When the hose is removed, the internal spring of the vacuum unit should push the control rod outward. If the vacuum diaphragm needs replacing, install a new unit that has been released for service. Vacuum diaphragm assembly identification is given at end of this Section.

Control Pressure Test—AOD

Line pressure and throttle pressure on the Automatic Overdrive Transmission is tested in the idle position (zero T.V.) and wide-open-throttle position. Line pressure and throttle pressure specifications can be found in the Technical Service Bulletin—Special Specifications Issue. In each of the two modes the Reverse specifications will be higher than the others.

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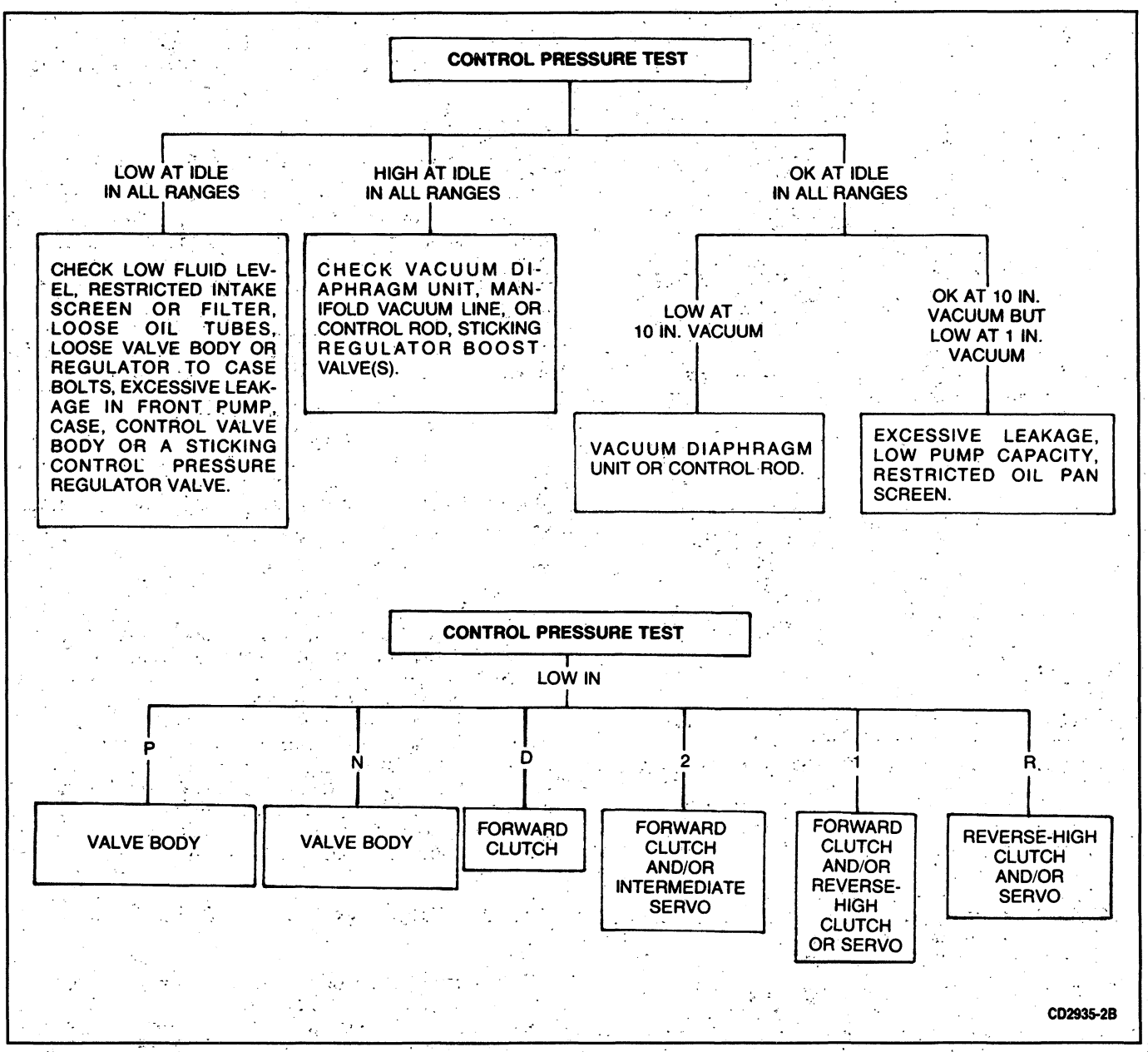


FIG. 8 Control Pressure Test Charts—C6

1. Be sure the T.V. linkage is properly adjusted.
2. Connect a 300 psi gauge to the line pressure port on the case left side just above the control lever (Fig. 9). Have sufficient flexible hose to make the gauge accessible while operating the engine.
3. Connect a 0-100 psi pressure gauge to the TV port on the right side of the case (see Fig. 9). Have sufficient flexible Hose to make the gauge accessible while operating the engine.

   CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken NOT to accelerate or decelerate rapidly. Possible transmission failure could result.

   NOTE: W.O.T. readings are to be made at full stall. However, be sure to run the engine at fast idle in neutral for cooling between test.
4. Run the engine until it is hot.

   CAUTION: Idle pressure must be read with the throttle off the fast idle cam.
5. Apply the service and parking brakes firmly and shift through all the ranges. Record the line pressure and the throttle pressure and compare it with specifications.

After making the control pressure tests, analyze the results to relate to the conditions in Figs. 10, 11 and 12.

Keep in mind that clutch and servo leakage may or may not show up on the control pressure test. This is because (1) the pump has a high output volume and the leak may not be severe enough to cause a pressure drop; and (2) orifices between the pump and pressure chamber may maintain pressure at the source, even with a leak downstream. Pressure loss caused by a less-than-major leak is more likely to show up at idle than at W.O.T. where the pump is delivering full volume.

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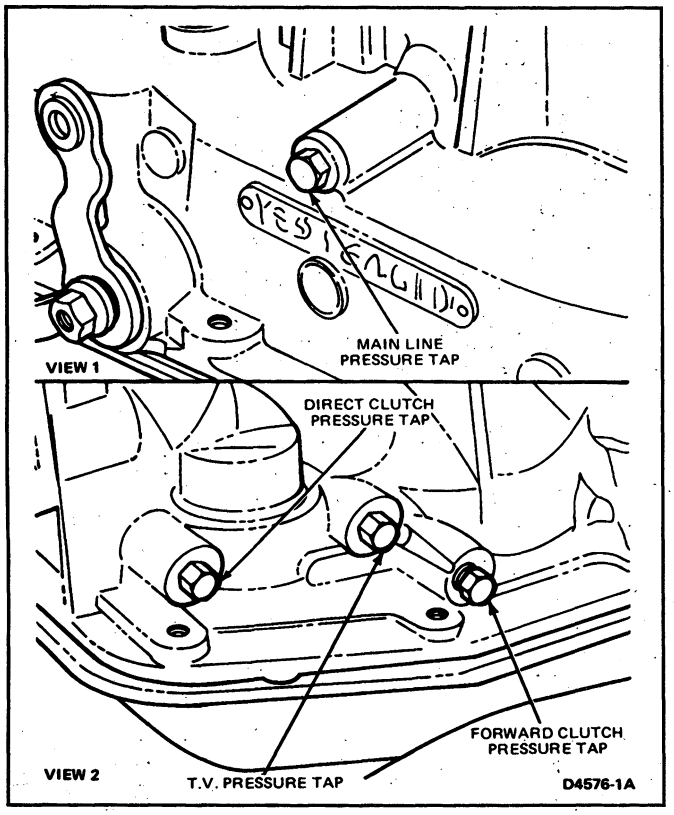


FIG. 9 Control Pressure Connecting Points—AOD

Conversely, if you are manipulating the T.V. linkage to simulate W.O.T., but actually testing at idle, the leak is more likely to cause a pressure loss in the W.O.T. position.

To further isolate leakage in a clutch or servo circuit, it is necessary to remove the oil pan and valve body, and to perform case air pressure tests.

Direct Clutch Pressure Test—AOD

The direct clutch pressure test outlined below will diagnose a low pressure condition or leakage in the direct clutch circuit. A difference of 15 psi or more between direct clutch pressure and line pressure (read at the forward clutch pressure tap) will prevent a 3-4 shift.

1. Attach 0-300 psi pressure gauges to the forward clutch pressure tap and to the direct clutch pressure tap (Fig. 9). Gauge accuracy must be capable of distinguishing a 15 psi difference. (If this test is done in conjunction with a control pressure test, pressure gauges will be attached to all pressure taps.) Have sufficient flexible hose to read the gauges in the vehicle.

   CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken not to accelerate or decelerate rapidly. Possible transmission failure could result.

2. Drive the vehicle. When pressure is applied to the direct clutch, note the difference between the line pressure read at forward clutch pressure tap and the direct clutch pressure.
3. If the difference in pressures is less than 15 psi, the direct clutch circuit is ok.
4. If the difference is greater than 15 psi, there could be a leak in the direct clutch pressure circuit. If the difference does exceed 15 psi, the gauges on line pressure and direct clutch pressure can be switched to confirm that gage calibration difference is not the cause.

Stall Test

Refer to Fig. 13.

The stall test checks converter clutch operation and installation, the holding ability of the forward clutch, reverse clutch, the low-reverse bands, the planetary one-way clutch and engine performance.

The test should be done only with the engine coolant and transmission fluid at proper levels and at operating temperature, and with the TV linkage set properly.

Apply the service and parking brakes firmly for each stall test.

1. Find the specified stall RPM for the vehicle by referring to the Technical Service Bulletin—Special Specifications Issue. Use a grease pencil to mark the RPM on the dial of a tachometer.
2. Connect the tachometer to the engine.
3. In each of the following ranges for Automatic Overdrive Ⓓ, D, 1, R; for C6,—D, 2, 1, R; press the accelerator to the floor and hold it just long enough to let the engine get to full RPM. While making this test, do not hold the throttle open for more than five seconds at a time.
4. Note the results in each range.
5. After each range, move the selector lever to N (neutral) and run the engine at 1000 RPM for about 15 seconds to cool the converter before making the next test.
6. Refer to Fig. 13 for corrective actions.

IMPORTANT: If the engine speed recorded by the tachometer exceeds the maximum limits given in the Specifications, release the accelerator immediately because clutch or band slippage is indicated.

Governor Check

C6

The governor can be checked at the same time as the Control Pressure Test is performed and in the same manner.

Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor. Disconnect and plug the vacuum line to the vacuum diaphragm unit. Connect the line from the distributor tester if available to the vacuum diaphragm unit. Vacuum pump can be used with an extended vacuum hose to operate from within the vehicle.

CAUTION: Never exceed 96 km (60 mph) speedometer speed.

Place the transmission in D (DRIVE), no load on the engine and apply 10 inches of vacuum to the vacuum diaphragm unit. Increase the speed slowly and watch the speedometer. Check the mph at which the control pressure cutback occurs. It should occur between 16-32 km (10-20 mph).

NOTE: After each test, move the selector to N (neutral) and run the engine at 1000 RPM to cool the transmission.

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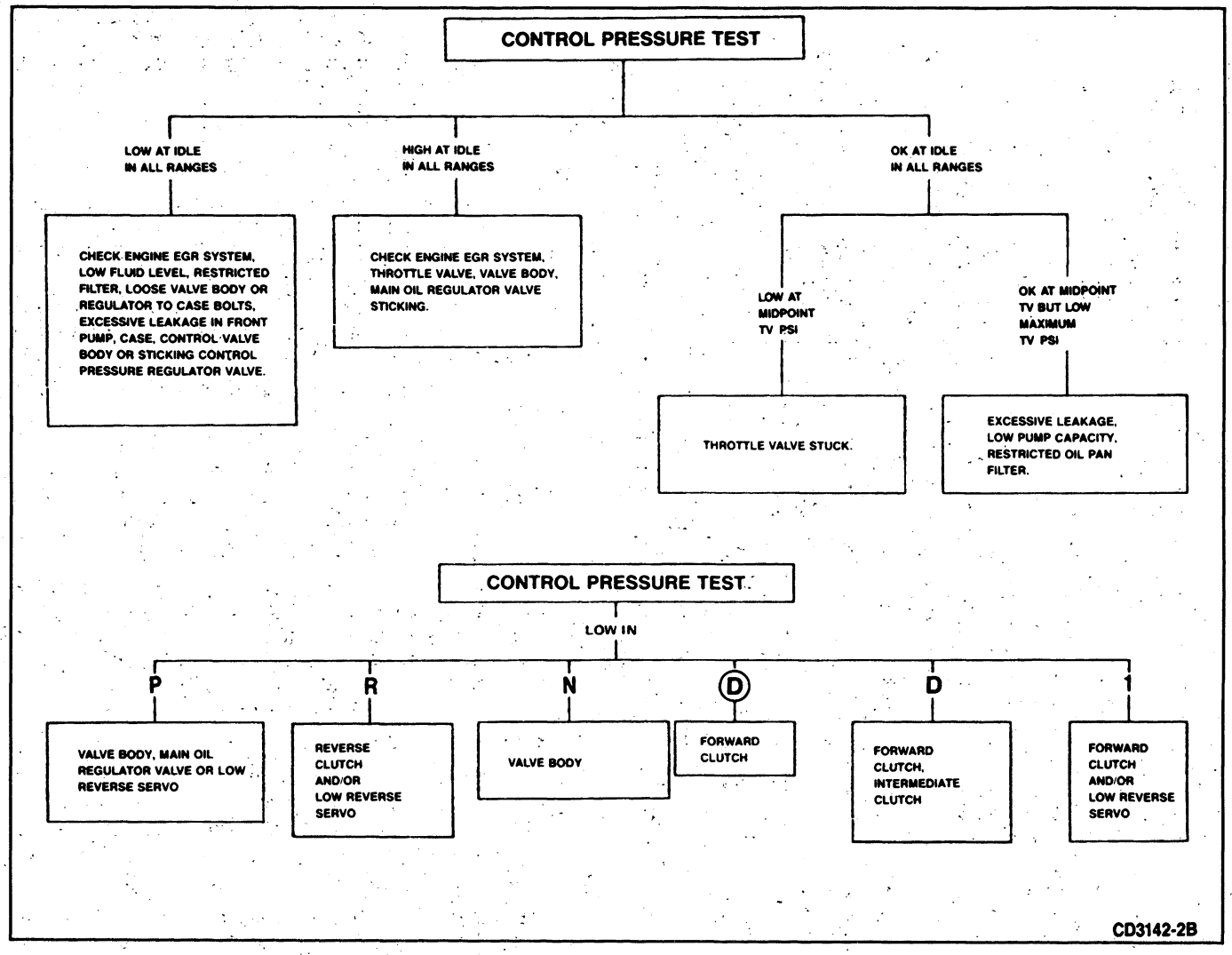


FIG. 10 Control Pressure Test Charts—AOD

The governor is good if the cutback occurs within these specifications. If the cutback does not occur within specifications, check shift speeds to verify that it is the governor and not a stuck cutback valve, then repair or replace the governor.

AOD

Perform a shift point check. (Road test or in shop). If the shift points are not within specifications, proceed with the following governor check. Accelerate vehicle to 40 km/h (25 mph) then back off throttle completely. The transmission should shift to third gear.

Shift Point Checks

Road Test

C6

This check will determine if the governor pressure and shift control valves are functioning properly.

Check the minimum throttle upshifts in D (DRIVE). The transmission should start in first gear, shift to second, and then shift to third, within the shift points listed in Technical Service Bulletin—Special Specifications Issue.

With the transmission in third gear, depress the accelerator pedal through the detent (to the floor). The transmission should shift from third to second or third to first, depending on the vehicle speed.

Check the closed throttle downshift from third to first by coasting down from about 48 km (30 mph) in third gear. The shift should occur within the limits listed in the Specifications.

When the selector lever is at 2 (SECOND), the transmission can operate only in second gear.

With the transmission in third gear and road speed over 80 km (50 mph) the transmission should shift to second gear when the selector lever is moved from D (DRIVE) to 2 (SECOND) or 1 (FIRST).

The transmission will downshift from second or third to first gear when this same manual shift is made below approximately 48 km (30 mph) with a C6 transmission.

Refer to the band application chart in Fig. 14 to aid in diagnosis of transmission conditions.

In Shop

A shift test can be performed in the shop to check shift valve operation, governor circuits, shift delay pressures, throttle boost and downshift valve action.

Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor. Disconnect and plug the vacuum line to the vacuum diaphragm unit

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Control Pressure Test Results:	
Control Pressure Condition	**Possible Causes**
Low in P	Valve body bolts loose, low reverse servo leakage.
Low in R	Reverse clutch leakage, low reverse servo leakage.
Low in N	Valve body bolts loose.
Low in Ⓓ	Forward clutch leakage, overdrive servo leakage, valve body bolts loose.
Low in D	Forward clutch leakage.
Low in 1	Forward clutch leakage, low reverse servo leakage.
Low at idle in all ranges.	Low fluid level, restricted oil filter, loose valve body bolts, pump leakage, case leakage, valve body leakage, excessively low engine idle, fluid too hot, main oil regulator valve sticking.
High at idle in all ranges.	T.V. linkage, valve body (throttle valve or main oil regulator valve sticking).
Okay at idle but low at W.O.T.	Internal leakage, pump leakage, restricted inlet screen, T.V. linkage, valve body (T.V. or T.V. limit valve sticking), main oil regulator valve sticking.

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FIG. 11 Control Pressure Test Results Chart—AOD

T.V. Pressure	Line Pressure	Range	Possible Cause
High at WOT	High at WOT	All	TV limit valve not regulating pressure — repair or replace valve body.
Low at WOT	Low at WOT	All	Throttle valve stuck — repair or replace valve body. TV linkage out of adjustment/damaged/binding — adjust and/or repair as necessary.

CD3143-2B

FIG. 12 TV Pressure and Line Pressure Test Results—AOD

(C6). Connect the line from the distributor tester vacuum pump to the vacuum diaphragm unit.

CAUTION: Never exceed 96 km (60 mph) speedometer speed.

1. To check the shift valves and governor circuits, apply 18 inches of vacuum to the transmission vacuum diaphragm unit. Place the transmission in Drive and make a minimum throttle 1-2 and 2-3 shift. At the shift points you will see the speedometer needle make a momentary surge and feel the driveline bump. If the shift points are within specification, the 1-2 and 2-3 shift valves and governor are OK.

   If the shift points are not within specification, perform a Governor Check to isolate the problem.

   NOTE: After each test, move the selector lever to Neutral, run the engine at 1000 rpm to cool the transmission.

2. To check the shift delay pressures and throttle boost, decrease the vacuum at the vacuum diaphragm to 0-2 inches. Make a 1-2 shift test. If the shift point raises to specification, the throttle boost and shift delay systems are functioning.

3. To check downshift valve action. Leave the vacuum to the vacuum diaphragm at 0-2 inches. Position the downshift linkage in the wide open throttle position (through the detent) and repeat the 1-2 shift test. The speed at the shift point should be higher.

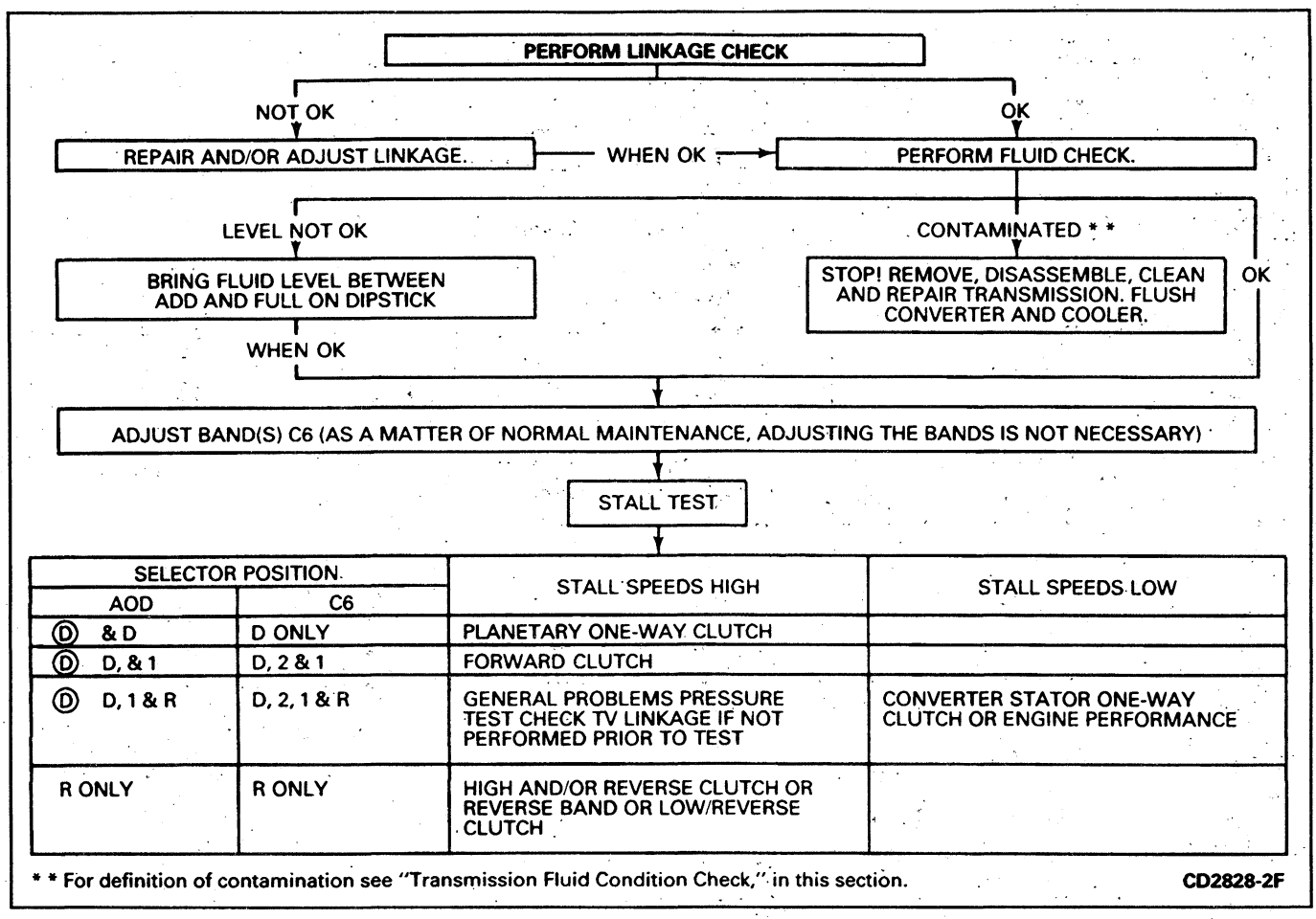
   Shift speed specifications can be found in the Technical Service Bulletin—Special Specifications Issue.

Shift Point Checks AOD

Road Test

This check will determine if the governor pressure and shift control valves are functioning properly. During

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SELECTOR POSITION		STALL SPEEDS HIGH	STALL SPEEDS LOW
AOD	C6		
Ⓓ & D	D ONLY	PLANETARY ONE-WAY CLUTCH	
Ⓓ D, & 1	D, 2 & 1	FORWARD CLUTCH	
Ⓓ D, 1 & R	D, 2, 1 & R	GENERAL PROBLEMS PRESSURE TEST CHECK TV LINKAGE IF NOT PERFORMED PRIOR TO TEST	CONVERTER STATOR ONE-WAY CLUTCH OR ENGINE PERFORMANCE
R ONLY	R ONLY	HIGH AND/OR REVERSE CLUTCH OR REVERSE BAND OR LOW/REVERSE CLUTCH	

* * For definition of contamination see "Transmission Fluid Condition Check," in this section. CD2828-2F

FIG. 13 Stall Diagnosis Test

the shift point check operation, if the transmission does not shift within specifications or certain gear ratios cannot be obtained, refer to the diagnosis wheel or to the symptom analysis Section of this book to resolve the problem.

Shift speed specifications can be found in the Technical Service Bulletin—Special Specifications Issue.

Choke on will effect shift points minimum throttle upshifts. Check minimum throttle upshifts in the fourth gear (overdrive). The transmission should start in first gear, shift to second gear then shift to third gear and finally shift to fourth gear, within the shift points specified in the shift speed specifications.

Forced Downshifts:

With the transmission in fourth gear (overdrive) depress the accelerator pedal to the floor. The transmission should downshift to third gear or to second gear, depending on vehicle road speed. Refer to the appropriate shift speed specifications.

Closed Throttle Downshifts

Closed throttle downshifts should be extremely difficult to detect. It may be necessary to attach pressure gauges to the forward and direct clutch pressure taps (Fig. 9) in order to detect 4-3 and 3-2 coast downshifts.

With gauges attached a 4-3 coast (closed throttle) downshift is signified by the application of the forward clutch (the psi reading from the gauge on the forward clutch pressure tap will indicate an increase in pressure from 0 psi to 60 psi). A 3-2 coast downshift is signified by the release of the direct clutch (the psi reading from the gauge on the direct clutch pressure tap will indicate a decrease in pressure from 60 psi to 0 psi). A 2-1 coast downshift should be imperceptible. The coast downshifts should occur within the limits set forth in the shift speed specifications.

When the shift selector is in manual low (1) the transmission will not upshift from first gear.

When the shift selector is moved from either Ⓓ (overdrive) or direct drive (D) ranges to the manual low (1) position, the transmission will downshift into second gear if the vehicle is moving over (approximately) 41 km/h (25 mph) and into first gear if the vehicle is moving less than (approximately) 41 km/h (25 MPH).

The overdrive band is applied when the transmission is in manual second. The low-reverse band is applied when the transmission is in manual first gear.

The automatic overdrive transmission will not shift into fourth gear (overdrive) at wide open throttle.

The Automatic Overdrive Transmission will not make a 4-1 downshift.

When the vehicle road speed drops below approximately 58 km/h (35 mph), the transmission automatically downshifts from Ⓓ (overdrive) into third gear.

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C6 AUTOMATIC TRANSMISSION CLUTCH AND BAND APPLICATION SUMMARY

Gear	Holding Members	Front Planetary Gearset			Rear Planetary Gearset		
		Driven	Held	Output	Driven	Held	Output
Manual Low 1	Forward Clutch Low-and-Reverse Clutch	Ring Gear	*Carrier	Sun Gear	Sun Gear	Carrier	Ring Gear
D Low	Forward Clutch One-way Clutch	Ring Gear	*Carrier	Sun Gear	Sun Gear	Carrier	Ring Gear
*The carrier is actually turning with the output shaft, but at a slower speed than the input.							
D Second or 2	Forward Clutch & Band	Ring Gear	Sun Gear	Carrier	EFFECTIVELY IN NEUTRAL		
High	Forward Clutch Reverse-and-High Clutch	Sun Gear Ring Gear	None	Carrier	TURNS AS A UNIT		
Reverse	Reverse-and-High Clutch Low-and-Reverse Clutch	EFFECTIVELY IN NEUTRAL			Sun Gear	Carrier	Ring Gear

AOD AUTOMATIC TRANSMISSION CLUTCH AND BAND APPLICATION SUMMARY

Gear	Intermediate Friction Clutch	Intermediate Roller Clutch	Overdrive Band	Reverse Clutch	Forward Clutch	Planetary (Low) One-Way Clutch	Low and Reverse Band	Direct Clutch
1 Range Low					Applied	Holding	Applied	
O/D and 3 Range Low					Applied	Holding		
Second (Intermediate)	Applied	Holding			Applied	Overruns		
Third (Direct)	Applied	Overruns			Applied	Overruns		Applied
Fourth (Overdrive)	Applied		Applied			Overruns		Applied
Reverse				Applied			Applied	

CD5040-2C

FIG. 14 Band Application Chart

In Shop

A shift test can be performed in the shop to check shift valve operation, governor circuits, shift delay pressures, throttle boost and downshift valve action.

Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor.

CAUTION: Never exceed 96 km/h (60mph) speedometer speed or rapidly apply the brakes to stop the rear wheels.

To check the shift valves and governor circuits, place the transmission in overdrive and make a minimum throttle 1-2, 2-3 and 3-4 shift test. When the shift occurs, you will see the speedometer needle make a momentary surge and feel the driveline bump. If the shift points are within specification, the 1-2, 2-3 and 3-4 shift valves and governor are OK.

If the shift points are not within specification, perform a Governor Check to isolate the problem.

Place the transmission in manual 2, no load on the engine and apply 10 inches of vacuum to the vacuum diaphragm unit. Increase the speed slowly and watch the speedometer. Check the mph at which the control pressure cutback occurs. It should occur between 16-32 km (10-20 mph).

NOTE: After each test, move the selector lever to N (Neutral) and run the engine at 1000 rpm to cool the transmission.

Decrease the vacuum at the vacuum diaphragm to 0.2 inches. Repeat the check. Control pressure cutback should occur between 48-80 km (30-50 mph).

The governor is good if the cutback occurs within these specifications. If the cutback does not occur within specifications, check shift speeds to verify that it is the governor and not a stuck cutback valve, then repair or replace the governor.

Shift speed specifications can be found in the Technical Service Bulletin—Special Specifications Issue.

Diagnosis Tips AOD Only

Some tips on diagnosing problems with specific components are:

INTERMEDIATE CLUTCH OR ONE-WAY CLUTCH—transmission shifts 1-3 or slips in second gear.

REVERSE CLUTCH—slip or no engagement in R. (Also can be caused by the low-reverse band or servo.)

FORWARD CLUTCH/PLANETARY LOW ONE-WAY CLUTCH—no engagement in forward ranges or slip in forward.

OVERDRIVE BAND OR SERVO—no fourth gear, slip in fourth gear, or no engine braking in second gear in range 1.

DIRECT CLUTCH—slip in third or fourth, or no upshift beyond second.

LOW-REVERSE BAND OR SERVO—no reverse or slip in reverse. Possibly no engine braking in manual low first gear, which would isolate the problem to the band rather than reverse clutch.

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Accumulators

Leaking seals on the accumulator pistons can cause their respective clutches to slip. If the 2-3 accumulator seals leak, the symptoms could resemble a direct clutch or forward clutch problem. A leaking 3-4 accumulator will cause a harsh 3-4 upshift.

T.V. Pressure Low

Another reminder: if the shifts seem soft or mushy, do not make any heavy throttle tests. Check and adjust the T.V. linkage before making a complete road test.

Air Pressure Checks

C6

A NO DRIVE condition can exist, even with correct transmission fluid pressure, because of inoperative clutches or bands. On automatic transmissions, an erratic shift can be caused by a stuck governor valve. The inoperative units can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the selector lever is at 2 (second) a NO DRIVE condition may be caused by an inoperative forward clutch. A NO DRIVE condition at D (drive) may be caused by an inoperative forward clutch or one-way clutch. When there is no drive in 1 (low) the difficulty could be caused by improper functioning of the forward clutch or simultaneous malfunction of the low-reverse band and the one-way clutch. Failure to drive in R (Reverse) could be caused by a malfunction of the reverse-high clutch or low-reverse band or clutch.

When you have a slip problem but don't know whether it is in the valve body or in the hydraulic system beyond the valve body, the air pressure tests can be very valuable.

To make the air pressure checks, loosen the oil pan bolts and lower one edge to drain the transmission fluid. Remove the oil pan and the control valve body assembly. The inoperative clutches or bands can be located by introducing air pressure into the various transmission case passages (Figs. 15 and 16).

Forward Clutch

Apply air pressure to the transmission case forward clutch passages (Figs. 15 and 16). A dull thud can be heard when the clutch piston is applied. If no noise is heard, place the finger tips on the input shell and again apply air pressure to the forward or front clutch passage. Movement of the piston can be felt as the clutch is applied.

Governor

Apply air pressure to the control pressure to governor passage (Figs. 15 and 16) and listen for a sharp clicking or whistling noise. The noise indicates governor valve movement.

Reverse-High Clutch

Apply air pressure to the reverse-high clutch (Figs. 15 and 16). A dull thud indicates that the reverse-high or rear clutch piston has moved to the applied position. If no noise is heard, place the finger tips on the clutch drum and again apply air pressure to detect movement of the piston.

Intermediate Servo

Hold the air nozzle in the front servo apply tube or the intermediate servo apply passages (Figs. 15 and 16).

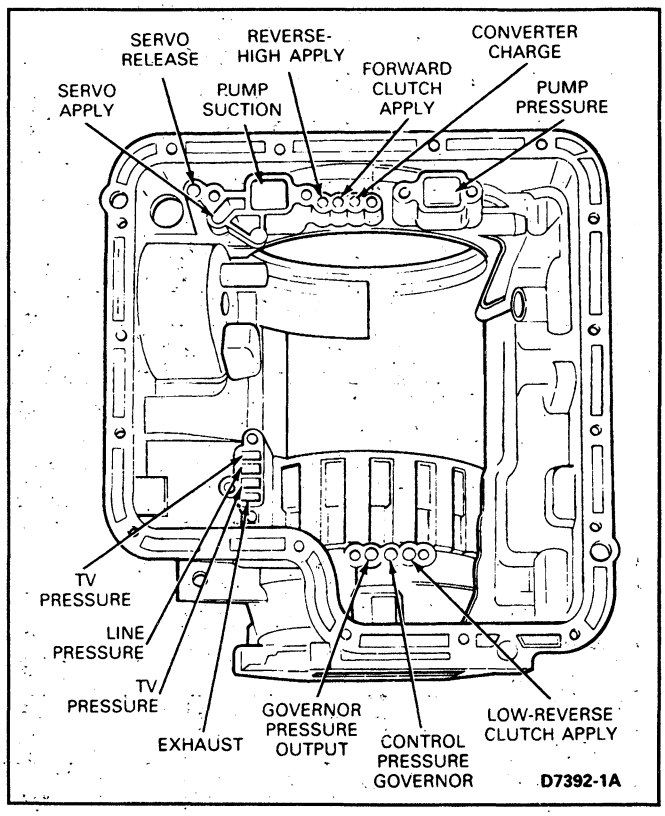


FIG. 15 Case Fluid Passage Hole Identification—C6 Automatic

Operation of the servo is indicated by a tightening of the front or intermediate band around the drum on C6 transmissions. Continue to apply air pressure to the servo apply tube or passage, and introduce air pressure into the front release tube or the intermediate servo release passage. The front or intermediate servo should release the band against the apply pressure.

Low-Reverse Clutch C6 Only

Apply air pressure to the low-reverse clutch apply passage (Fig. 15). A dull thud should be heard if the clutch is operating properly. If the passages are clear, remove the clutch assemblies, and clean and inspect the malfunctioning clutch to locate the trouble.

Air Pressure Checks AOD

A NO DRIVE condition can exist even with the correct transmission fluid pressure because of inoperative clutches or bands. The inoperative units can be located by substituting air pressure for fluid pressure through a series of passages to determine the location of the malfunction (Fig. 17).

A NO DRIVE condition in Ⓓ (overdrive) may be caused by an inoperative forward clutch or one-way clutch. When there is a NO DRIVE in 1st. (first), the difficulty could be caused by improper functioning of the forward clutch or low-reverse band and the one-way clutch.

Air pressure checks can also isolate slip problems as to whether the source of the problem is in the valve body or in the hydraulic system beyond the valve body.

The passages can be tested adequately with air pressure regulated at 40 psi. However, it may be necessary to use higher air pressure (90 psi) if there is difficulty in hearing the clutches apply.

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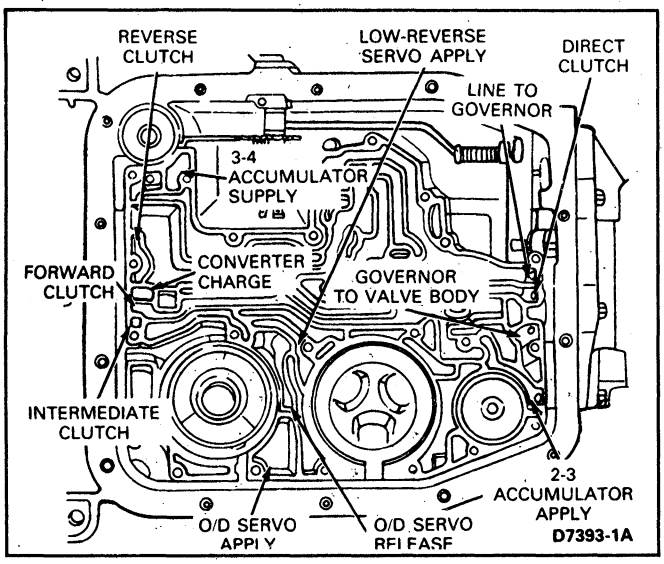


FIG. 16 Air Pressure Checks—Case Apply Passages—Automatic Overdrive Transmission (AOD)

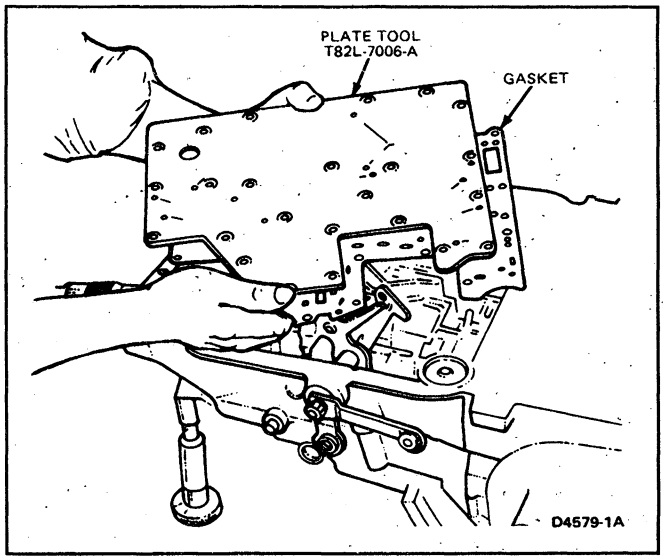


FIG. 18 Installing Air Pressure Plate Service Tool and Main Control Gasket—AOD

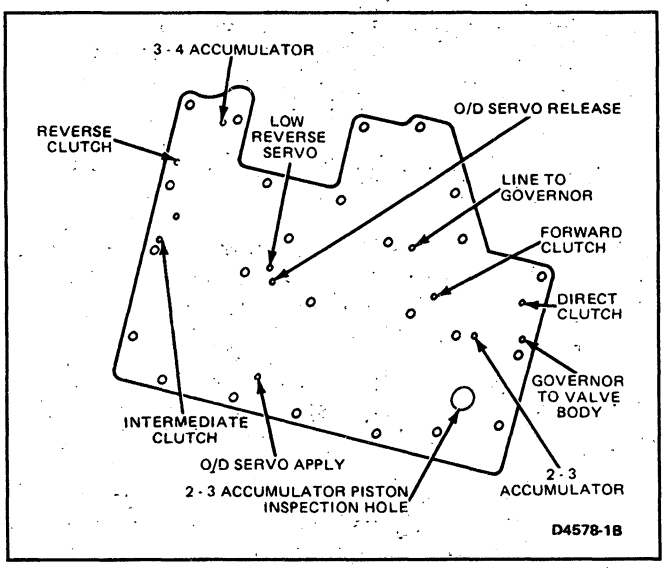


FIG. 17 Air Pressure Check Plate—AOD Transmission Service Tool T82L-7006-A

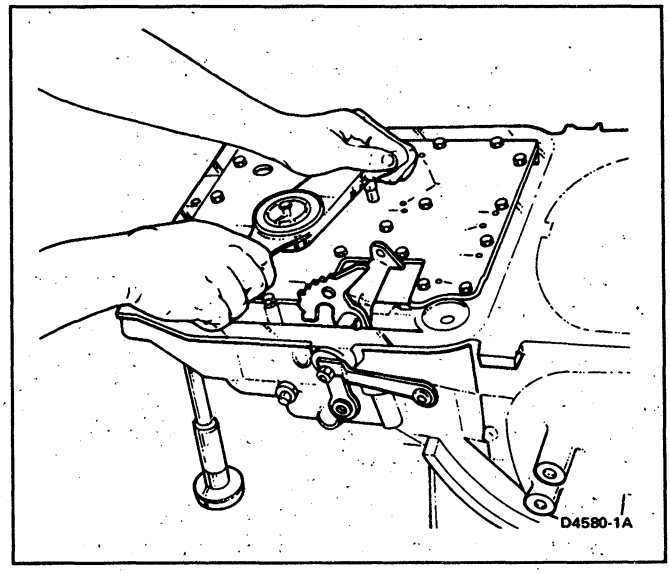


FIG. 19 Tighten T82P-7006-C Cap Screws—AOD

Use the main control gasket and service Tool T82L-7006-A with T82P-7006-C cap screws (M6 x 16) to seal the case apply passages (Figs. 17 and 18). Tighten the cap screws 9-11 N·m (80-100 in. lb.) (Fig. 19). Apply air to the apply passages in the service tool plate using the air nozzle service tool Tool-7000-DE with the rubber tip Tool-7000-DD or equivalent.

All locations of the case apply passages are stamped on the service tool plate. The transmission case apply holes are illustrated in Fig. 20.

Notes on Air Checks:

If the servos or the accumulators do not operate, disassemble, clean and inspect them to locate the source of the trouble. If air pressure applied to either of the clutch passages fails to operate a clutch or operates both clutches at once, remove and with air pressure, check the fluid passages in the case and front pump to detect obstructions.

Clutches—Reverse Clutch, Forward Clutch, Intermediate Clutch and Direct Clutch

Apply air pressure to the appropriate passage in the service tool (Fig. 17). A dull thud can be heard or felt on the case as the clutch piston is applied (Fig. 21). Movement of the reverse clutch drum may also be detected when the reverse clutch passage is pressure tested (Fig. 21).

3-4 Accumulator

Apply air pressure to the 3-4 accumulator apply passage. The accumulator piston should unseat (Fig. 22).

2-3 Accumulator

Apply air pressure to the 2-3 accumulator apply passage. The accumulator piston should unseat. This can be detected by inserting a metal rod into the 2-3 piston hole. When the piston unseats the rod will move. Also, a thud can be heard when the piston applies (Fig. 23).

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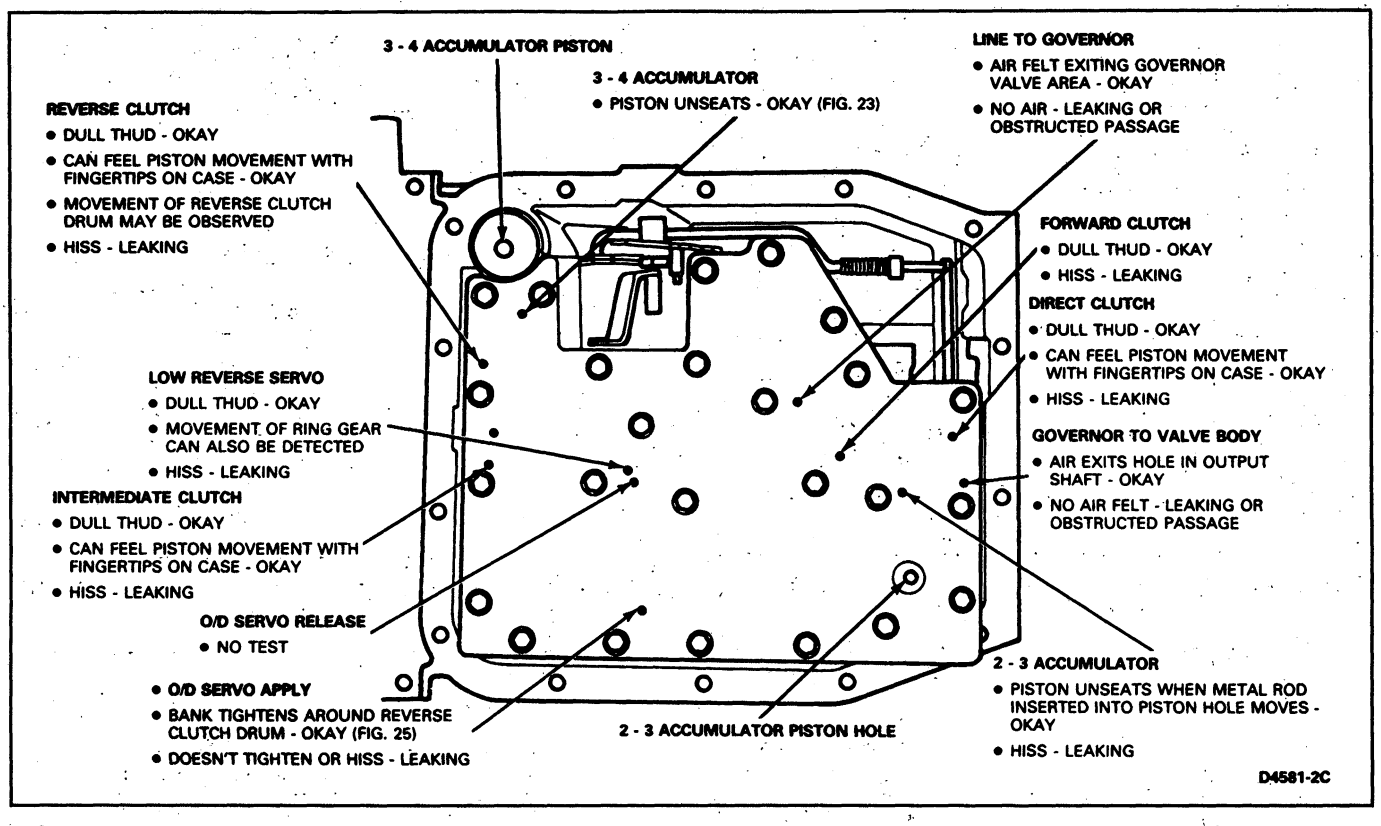


FIG. 20 Air Pressure Test—AOD

Overdrive Servo

Apply air pressure to the overdrive O/D servo apply passage in the service tool plate. Operation of the band is indicated by the tightening of the band around the reverse clutch drum (Fig. 24). The O/D servo will return to the release position as a result of spring force from the release spring. Also, when the servo returns to the release position, a thud can be felt on the O/D servo cover. The band will then relax.

Low-Reverse Servo

Apply air pressure to the low-reverse servo apply passage in the service tool plate. A dull thud can be heard when the low-reverse band tightens around the planetary assembly drum surface. Also, movement of the ring gear can be detected (Fig. 25).

Governor

Apply air pressure to the line to governor passage while holding finger near the governor valve (Fig. 26). If air is felt exiting the valve area, the passage is unobstructed.

To Air pressure check the governor to valve body passage, remove the governor. Apply air pressure to the passage while holding finger over holes in the output shaft (Fig. 27). If air exists in one of the holes, the passage is unobstructed.

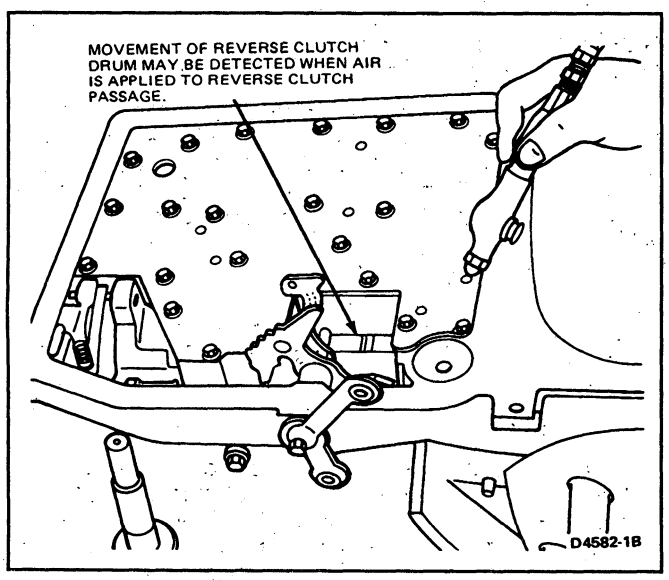


FIG. 21 Air Pressure Test—Reverse Clutch—AOD

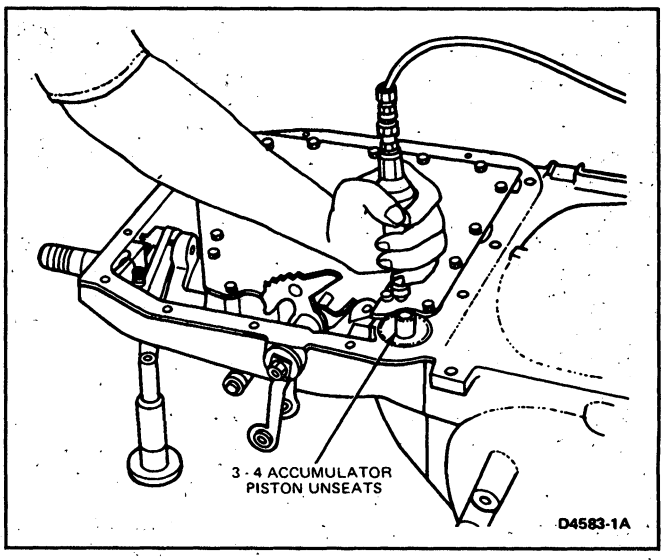


FIG. 22 Air Pressure Test—3-4 Accumulator—AOD

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Diagnosis Guides

The diagnosis guides in this Section can be used as an aid when diagnosing automatic transmissions.

DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Slow initial engagement.	1. Improper fluid level.	1. Perform fluid level check.
	2. Damaged or improperly adjusted linkage.	2. Service or adjust linkage.
	3. Contaminated fluid.	3. Perform fluid condition check.
	4. Improper clutch and band application, or low main control pressure.	4. Perform control pressure test.
Rough initial engagement in either forward or reverse. Rough initial engagement — AOD.	1. Improper fluid level.	1. Perform fluid level check.
	2. High engine idle.	2. Adjust idle to specifications. Check VRV for 7.3L Diesel, C6 applications (Section 17-10).
	3. Automatic choke on (warm temp.).	3. Disengage choke.
	4. Looseness in the driveshaft, U-joints or engine mounts.	4. Service as required.
	5. Improper clutch or band application, or oil control pressure.	5. Perform control pressure test.
	6. Sticking or dirty valve body.	6. Clean, service or replace valve body.
Harsh engagements — (warm engine).	1. Improper fluid level.	1. Perform fluid level check.
	2. TV cable — short.	2. Adjust TV cable.
	3. Engine curb idle too high.	3. Check engine curb idle. Check VRV for 7.3L Diesel, C6 applications (Section 17-10).
	4. Valve body bolts — loose/too tight.	4. Tighten to specification.
	5. Valve body dirty/sticking valves.	5. Determine source of contamination. Service as required.
No/delayed forward engagement (reverse OK).	1. Improper fluid level.	1. Perform fluid level check.
	2. Manual linkage — misadjusted/ damaged.	2. Check and adjust or service as required.
	3. Low main control pressure. (Leakage.) Forward clutch stator support seal rings leaking (#3, #4).	3. Control pressure test, note results.
	4. Forward clutch assembly burnt/ damaged/leaking check ball in cylinder/ leaking piston seal rings.	4. Perform air pressure test.
	5. Valve body bolts — loose/too tight.	5. Tighten to specification.
	6. Valve body dirty/sticking valves.	6. Determine source of contamination. Service as required.
	7. Transmission filter plugged.	7. Replace filter.
	8. Pump damaged/leaking.	8. Visually inspect pump gears. Replace pump if necessary.
No/delayed reverse engagement (forward OK).	1. Improper fluid level.	1. Perform fluid level check.
	2. Manual linkage misadjusted/damaged.	2. Check and adjust or service as required.
	3. Low main control pressure in reverse. Reverse clutch stator support seal rings leaking (#1, #2), (AOD). High reverse clutch OK.	3. Control pressure test.

CD4921-2C

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
No/delayed reverse engagement (forward OK) (continued).	4. Reverse clutch assembly burnt/worn/ leaking check ball in piston/leaking piston seal rings.	4. Perform air pressure test.
	5. Valve body bolts loose/too tight.	5. Tighten to specification.
	6. Valve body dirty/sticking valves.	6. Determine source of contamination. Service as required.
	7. Transmission filter plugged.	7. Replace filter.
	8. Pump damaged.	8. Visually inspect pump gears. Replace if necessary.

CD4922-2B

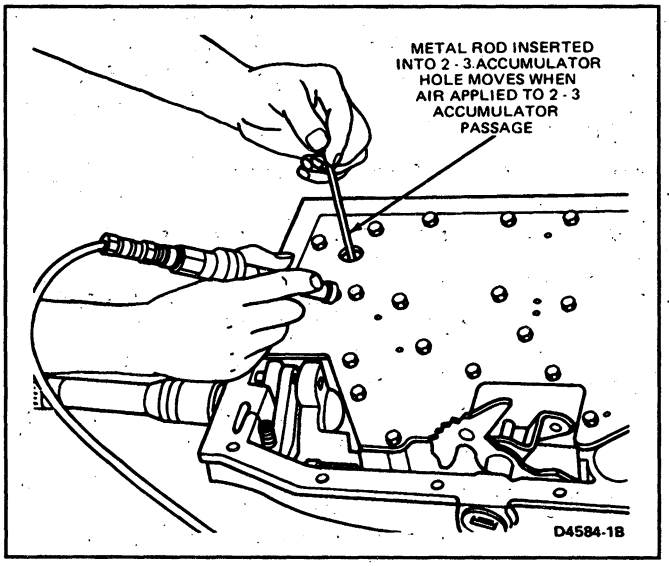


FIG. 23 Air Pressure Test—2-3 Accumulator—AOD

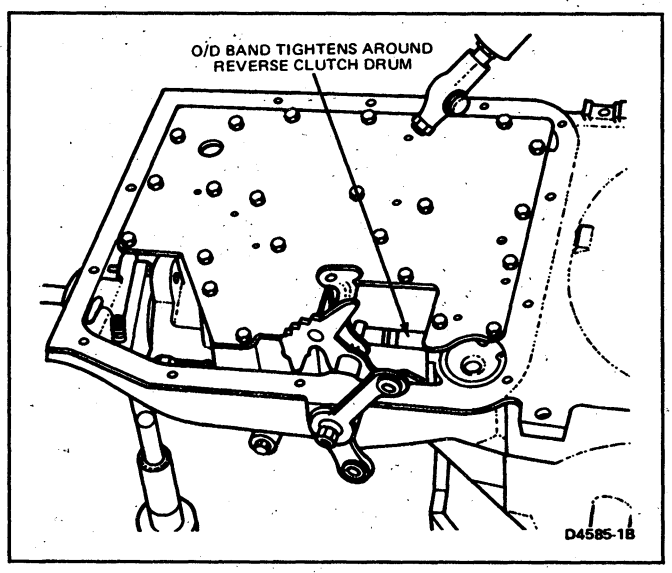


FIG. 24 Air Pressure Test—O/D Servo Apply—AOD

REMOVAL AND INSTALLATION

Vacuum Diaphragm C6

Removal and Installation

1. Disconnect the hose from the vacuum unit.

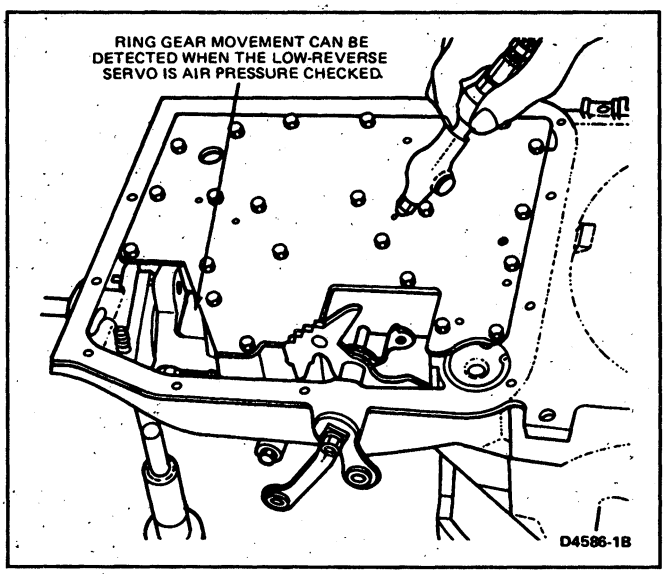


FIG. 25 Air Pressure Test—Low Reverse Servo—AOD

2. Remove the vacuum unit retaining bracket bolt and bracket (Fig. 28). **Do not pry or bend the bracket.** Pull the vacuum unit from the transmission case.
3. Remove the vacuum unit control rod from transmission case.
4. Install the vacuum unit control rod in transmission case.
5. Push the vacuum unit into the case and secure with the retaining bracket and bolt. Tighten the bolt to 17-21 N·m (12-16 ft-lbs) on C6 transmissions.
6. Install the vacuum unit hose to the diaphragm connector.

Transmission Fluid Drain and Refill

Normal maintenance and lubrication requirements do not necessitate periodic automatic transmission fluid changes.

If a major repair, such as a clutch band, bearing, etc., is required in the transmission, it will have to be removed for service. At this time the converter, transmission cooler and cooler lines must be thoroughly flushed to remove any dirt.

On light trucks equipped with automatic transmissions the following should apply:

When used under continuous or severe conditions, the transmission and the torque converter should be drained and refilled with the

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
No/delayed reverse engagement and/or no engine braking in manual low ①.	1. Improper fluid level.	1. Perform fluid level check.
	2. TV cable out of adjustment (AOD).	2. Service or adjust TV cable.
	3. Low reverse servo piston seal leaking.	3. Check and replace piston seal.
	4. Low reverse band/servo piston burnt/ worn (AOD).	4. Perform air pressure test.
	5. Planetary low one way clutch damaged.	5. Deterine cause of condition. Service as required.
No engine braking in manual second gear.	1. Intermediate band out of adjustment.	1. Adjust intermediate band.
	2. Improper band or clutch application, or oil pressure control system.	2. Perform control pressure test.
	3. Intermediate servo leaking.	3. Perform air pressure test of intermediate servo for leakage. Service as required.
	4. Intermediate one way clutch damaged.	4. Replace.
	5. Polished or glazed band or drum.	5. Service or replace as required.
Forward engagement slips/shutters/ chatters.	1. Improper fluid level.	1. Perform fluid level check.
	2. TV cable misadjusted (long) (AOD).	2. Adjust TV cable.
	3. Manual linkage misadjusted/damaged.	3. Check and adjust or service as required.
	4. Low main control pressure.	4. Control pressure test.
	5. Valve body bolts — loose/too tight.	5. Tighten to specification.
	6. Valve body dirty/sticking valves.	6. Determine source of contamination. Service as required.
	7. Forward clutch piston ball check not seating/leaking.	7. Replace forward clutch cylinder. Service transmission as required.
	8. Forward clutch piston seals cut/worn.	8. Replace seals and service clutch as required.
	9. Forward clutch stator support seal rings #3, #4 leaking (AOD).	9. Replace stator support seal rings.
	10. Low one way clutch (planetary) damaged.	10. Determine cause of condition. Service as required.
Reverse shudder/chatters/slips.	1. Improper fluid level.	1. Perform fluid level check.
	2. Low main control pressure in reverse.	2. Control pressure test.
	3. Low — reverse servo/ leaking.	3. Air pressure test; visually inspect seal rings and piston bore.
	4. Low (planetary) one-way clutch damaged.	4. Determine cause of condition. Service as required.
	5. Reverse clutch drum bushing damaged.	5. Determine cause of condition. Service as required.
	6. Reverse clutch stator support seal ring/ring grooves worn/damaged.	6. Determine cause of condition. Service as required.
	7. Reverse clutch piston seals cut/worn.	7. Determine cause of condition. Service as required.
	8. Reverse band out of adjustment or damaged.	8. AOD has no adjustment. Service as required.
	9. Looseness in the driveshaft, U-joints or engine mounts.	9. Service as required.

CD3145-2F

specified fluid at intervals directed in the maintenance or owners manual.

Refer to the Truck Performance Specifications Book or the end of this Section for fluid requirements.

NOTE: Fluid level indicator should be used to determine actual fluid requirements. Check fluid level when the transmission is at normal operating temperature. Do not overfill.

Procedures for partial drain and refill, due to in-vehicle repair operation, are as follows:

C6 Transmissions

1. Raise the vehicle on a hoist or jack stands.
2. Place a drain pan under the transmission.
3. Loosen the pan attaching bolts and drain the fluid from the transmission.
4. When fluid has drained to the level of the pan flange, remove the rest of the pan bolts working from the rear and both sides of the pan to allow it to drop and drain slowly.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
No drive, slips or chatters in first gear in D. All other gears normal. First gear in D or Ⓓ Automatic Overdrive transmission.	1. Damaged or worn planetary one-way clutch.	1. Service or replace one-way clutch.
No drive, slips or chatters in second gear.	1. Intermediate band out of adjustment (C6). 2. Intermediate friction clutch or one-way clutch (AOD). 3. Intermediate clutch piston bleed hole blocked or not positioned at 12 o'clock (AOD). 4. Improper band or clutch application, or control pressure. 5. Damaged or worn intermediate servo piston seals and/or internal leaks. 6. Dirty or sticking valve body. 7. Polished, glazed intermediate band or drum (C6).	1. Adjust intermediate band. 2. Service as required. 3. Clean and install bleed hole at 12 o'clock position. 4. Perform control pressure test. 5. Perform air pressure test. 6. Clean, service or replace valve body. 7. Replace or service as required.
Starts up in 2nd or 3rd.	1. Improper band and/or clutch application, or oil pressure control system. 2. Intermediate clutch pack clearance too tight (AOD). 3. Damaged or worn governor. Sticking governor. 4. Valve body loose. 5. Dirty or sticking valve body. 6. Cross leaks between valve body and case mating surface.	1. Perform control pressure test. 2. Check intermediate clutch pack clearance. 3. Perform governor check. Replace or service governor, clean screen. 4. Tighten to specification. 5. Clean, service or replace valve body. 6. Service or replace valve body and/or case as required.
Shift points incorrect.	1. Improper fluid level. 2. Vacuum line damaged, clogged or leaks (C6). 3. Improper operation of EGR system (C6). 4. TV cable out of adjustment (AOD). 5. Improper speedometer gear installed. 6. Improper clutch or band application, or oil pressure control system. 7. Damaged or worn governor. 8. TV control rod or vacuum diaphragm bent sticking or leaks, (C6). 9. Dirty or sticking valve body. 10. Vacuum regulator valve misadjusted or damaged, (C-6 with 7.3L Diesel).	1. Perform fluid level check. 2. Perform vacuum supply test. Check VRV adjustment on 7.3L Diesel, C6 application. 3. Service or replace as required. 4. Service or adjust TV cable. Check VRV adjustment on 7.3L Diesel, C6 application. 5. Replace gear. 6. Perform shift test and control pressure test. 7. Service or replace governor — clean screen. 8. Replace. 9. Clean, service or replace valve body. 10. Check adjustment and function. Adjust or replace.
All upshifts harsh/delayed or no upshifts.	1. Improper fluid level. 2. AOD Only — TV cable — short. 3. Manual linkage — misadjusted/ damaged. 4. Governor sticking. 5. Main control pressure too high. 6. Valve body bolts — loose/too tight. 7. Valve body dirty/sticking valves.	1. Perform fluid level check. 2. Adjust TV cable. Service as required. 3. Check and adjust or service as required. 4. Perform governor test. Service as required. 5. Control pressure test. Service as required. 6. Tighten to specification. 7. Determine source of contamination. Service as required.

CD4913-2D

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
All upshifts harsh/delayed or no upshifts (continued).	8. Vacuum leak to diaphragm unit (C6).	8. Check vacuum lines to diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. Check VRV adjustment on 7.3L Diesel, C6 application.
	9. Vacuum regulator valve misadjusted or damaged, (C6 with 7.3L Diesel).	9. Check adjustment and function. Adjust or replace.

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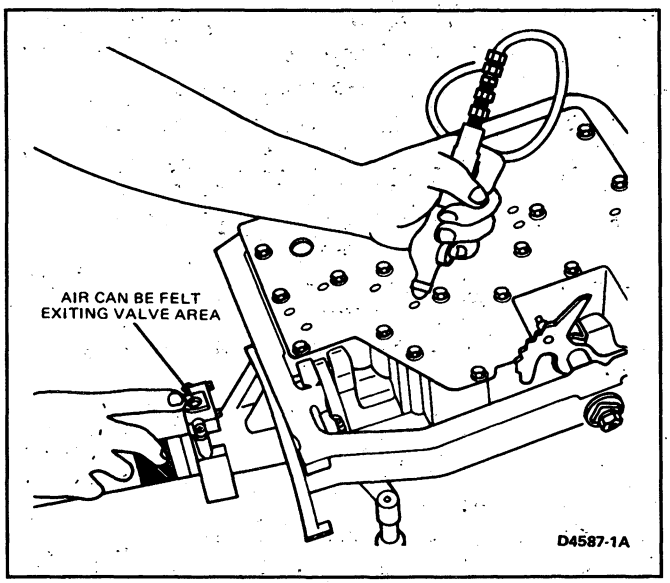


FIG. 26 Air Pressure Test—Line to Governor—AOD

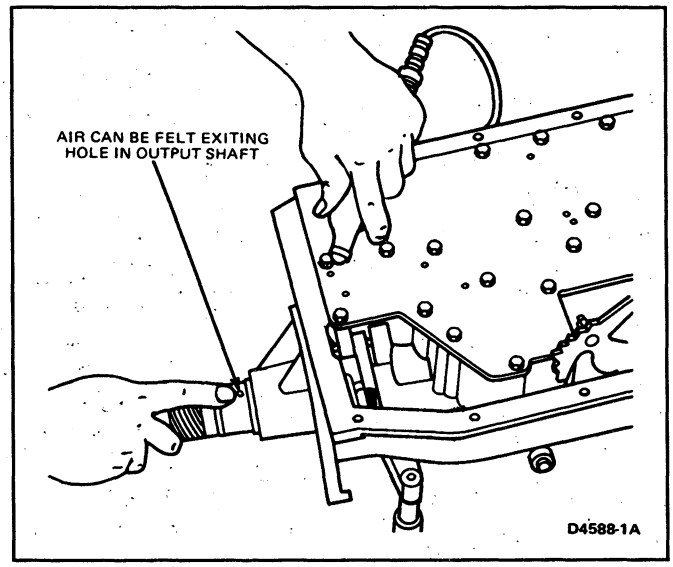


FIG. 27 Air Pressure Test—Governor to Valve Body—AOD

5. When all fluid has drained from the transmission, remove and thoroughly clean the pan and the screen. Discard the pan gasket.
6. Place a new gasket on the pan, and install the pan on the transmission. Tighten the bolts to specifications.
7. Add 4.7 liters (5 quarts) shallow pan, or 5.6 liters (6 quarts) deep pan of fluid to the transmission through the filler tube.
8. Check the fluid level.

AOD Transmissions

1. Raise the vehicle on a hoist or jack stands.
2. Place a drain pan under the transmission.
3. Loosen the pan attaching bolts and drain the fluid from the transmission.
4. When fluid has drained to the level of the pan flange, remove the rest of the pan bolts working from the rear and both sides of the pan to allow it to drop and drain slowly.
5. When all fluid has drained from the transmission, remove and thoroughly clean the pan. Discard the AOD filter, filter gasket, oil pan gasket and valve body gasket.
6. Install new oil pan gasket, filter and filter gasket on AOD. **Do not reuse the old one.**
7. Place a new gasket on the pan, and install the pan on the transmission. Tighten bolts to specifications.

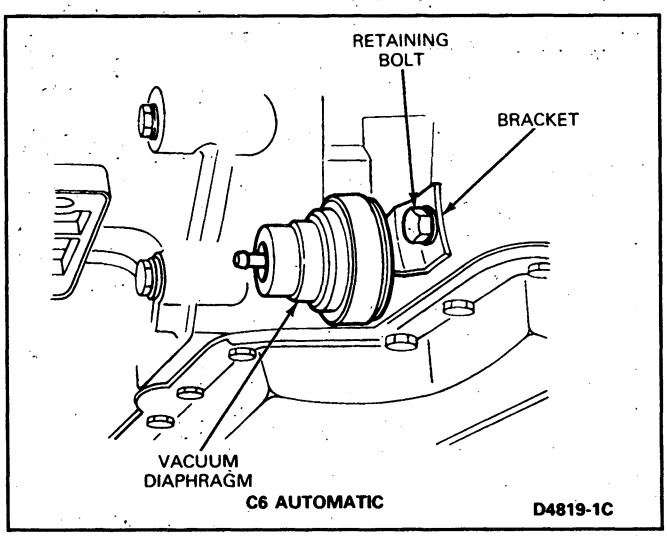


FIG. 28 Vacuum Diaphragm Installed—C-6 Transmission

8. Add 2.8 liters (3 quarts) of fluid to the transmission through the filler tube.
9. Check the fluid level following the checking procedures as described in this Section.

If it is necessary to perform a complete drain and refill, it will be necessary to remove the residual fluid from the torque converter and the cooler lines. To drain the torque converter:

1. Remove the low engine dust cover.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Mushy/early all upshifts/pile up upshifts.	1. TV cable misadjusted (long)/sticking/ damaged (AOD).	1. Adjust TV cable. Service as required. Check VRV for 7.3L Diesel, C6 application.
	2. Low main control pressure.	2. Control pressure test. Note results.
	3. Valve body bolts loose/too tight.	3. Tighten to specification.
	4. Valve body valve or throttle control valve sticking.	4. Determine source of contamination. Service as required.
	5. Governor valve sticking.	5. Perform governor test. Repair as required.
	6. TV control rod too short.	6. Install correct TV control rod.
	7. Vacuum regulator valve misadjusted or damaged. (C6 with 7.3L Diesel.)	7. Check adjustment and function. Adjust or replace.
No 1-2 upshift.	1. Improper fluid level.	1. Perform fluid level check.
	2. For 7.3L Diesel, C6 application — VRV.	2. Check VRV for 7.3L Diesel, C6 application.
	3. Manual linkage — misadjusted/ damaged.	3. Check and adjust or service as required.
	4. Low main control pressure to intermediate friction clutch (AOD).	4. Control pressure test. Note results.
	5. Governor valve sticking. Intermediate band out of adjustment (C6).	5. Perform governor test. Service as required. Adjust intermediate band.
	6. Vacuum diaphragm bent, sticking, leaks.	6. Check diaphragm unit. Service as necessary.
	7. Valve body bolts — loose/too tight.	7. Tighten to specification.
	8. Valve body dirty/sticking valves.	8. Determine source of contamination. Service as required.
	9. Intermediate clutch/band and or servo assembly burnt.	9. Perform air pressure test.
Rough/harsh/delayed 1-2 upshift.	1. Improper fluid level.	1. Perform fluid level check.
	2. Poor engine performance.	2. Tune engine.
	3. For 7.3L Diesel, C6 application — VRV.	3. Check VRV for 7.3L Diesel, C6 application.
	4. Intermediate band out of adjustment (C6).	4. Adjust intermediate band.
	5. Main control pressure too high.	5. Control pressure test. Note results.
	6. Governor valve sticking.	6. Perform governor test. Service as required.
	7. Engine vacuum leak (C6).	7. Check engine vacuum lines. Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests.
	8. Valve body bolts — loose/too tight.	8. Tighten to specifications.
	9. Valve body dirty/sticking valves.	9. Determine source of contamination. Service as required.
	10. Vacuum regulator valve misadjusted or damaged C6 with 7.3L Diesel.	10. Check adjustment and function. Adjust or replace.

CD4915-2D

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Mushy/early/soft/slipping 1-2 upshift.	1. Improper fluid level.	1. Perform fluid level check.
	2. Incorrect engine performance.	2. Tune adjust engine idle as required.
	3. For 7.3L Diesel, C6 application — VRV.	3. Check VRV for 7.3L Diesel, C6 application.
	4. Intermediate band out of adjustment (C6)	4. Adjust intermediate band.
	5. Low main control pressure.	5. Control pressure test. Note results.
	6. Valve body bolts loose/too tight.	6. Tighten to specification.
	7. Valve body dirty/sticking valves.	7. Determine source of contamination. Service as required.
	8. Intermediate friction clutch burnt/worn (AOD).	8. Determine cause of condition. Service as required.
	9. Governor valve sticking	9. Perform governor test. Service as required.
	10. Damaged intermediate servo or band.	10. Perform air pressure test. Service as required.
	11. Polished, glazed band or drum (C6).	11. Service or replace as required.
	12. Vacuum regulator valve misadjusted or damaged. (C-6 with 7.3L Diesel.)	12. Check adjustment and function. Adjust or replace.
No 2-3 upshift.	1. Low fluid level.	1. Perform fluid level check.
	2. For 7.3L Diesel, C6 application — VRV.	2. Check VRV for 7.3L Diesel, C6 application.
	3. Low main control pressure to direct clutch.	3. Control pressure test. Note results.
	4. Valve body bolts — loose/too tight.	4. Tighten to specification.
	5. Valve body dirty/sticking valves.	5. Determine source of contamination, then service as required.
	6. Direct clutch (or reverse/high clutch) assembly burnt/worn.	6. Stall test. Determine cause of condition. Service as required.
	7. Converter damper hub/weld broken (AOD).	7. Perform converter damper hub/weld check. Replace torque converter if required.
Harsh/delayed 2-3 upshift.	1. Incorrect engine performance.	1. Check engine tune-up.
	2. Engine vacuum leak (C6).	2. Check engine vacuum lines. Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. Check VRV for 7.3L Diesel, C6 application.
	3. For 7.3L Diesel, C6 application — VRV.	3. Check VRV for 7.3L Diesel, C6 application.
	4. 2-3 accumulator piston apply passage plugged/omitted (AOD).	4. Remove 2-3 accumulator piston and visually inspect or air test for plugging condition or omission.
	5. 2-3 accumulator piston seals cut/worn (AOD).	5. Replace seals, determine cause of condition. Service as required.
	6. Damaged 2-3 accumulator (AOD).	6. Service as required.

CD4917-2D

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Harsh/delayed 2-3 upshift (continued).	7. Damaged or worn intermediate servo release and high clutch piston check ball (C6).	7. Air pressure test the intermediate servo apply and release the high clutch piston check ball. Service as required.
	8. Valve body bolts — loose/too tight.	8. Tighten to specification.
	9. Valve body dirty/sticking valves. 2-3 capacity modulator valve (AOD).	9. Determine source of condition. Service as required.
	10. Vacuum diaphragm or TV control rod bent, sticking, leaks.	10. Check diaphragm and rod. Replace as necessary.
	11. Vacuum regulator valve misadjusted or damaged. (C-6 with 7.3L Diesel.)	11. Check adjustment and function. Adjust or replace.

CD4918-2C

2. Rotate the torque converter until the drain plug comes into view.
3. Remove the drain plug and allow the transmission fluid to drain. Note: It is recommended that this procedure be performed prior to other operations to allow sufficient time for the converter to drain properly.
4. Flush the cooler lines completely.
5. When adding fluid, fill to the capacity required for that transmission.

Fluid Cooler Lines

When fluid leakage is found from the fluid cooler, the cooler must be replaced. Cooler replacement is described in the Cooling System Section of Group 27.

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the old tube as a guide, bend the new tube as required. Add the necessary fittings, and install the tube.

After the fittings have been tightened, add fluid as needed, and check for fluid leaks.

CLEANING AND INSPECTION

Transmission

It is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. The cleaning of debris from the direct clutch piston, the forward clutch cylinder, and reverse clutch piston check balls are often omitted. This omission can lead to a repeat servicing of the transmission.

During overhaul inspect all hardware for evidence of overheating. Any overheating will be indicated by heat stained blue surfaces.

Clean the parts with suitable solvent and use moisture-free air to dry off all the parts and clean out fluid passages.

The composition clutch plates, bands and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution. To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in transmission fluid specified for that transmission type for fifteen minutes before being assembled.

Do not reuse the control valve body to filter gasket or try to clean in solvent and reuse the oil filter on AOD. Upon reassembly of the transmission replace both the valve body to filter gasket and the oil filter on the AOD transmission.

Control Valve Body

1. Clean all parts thoroughly in clean solvent, and blow dry with moisture-free compressed air. **If the valve body-to-screen gasket is removed on a C6 Transmission, the gasket should not be cleaned in a degreaser, solvent or any type of detergent solution. To clean the gasket, wipe it off with a lint-free cloth. For AOD, replace the valve body to filter gasket.**
2. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Use crocus cloth to polish valves and plugs. Avoid rounding the sharp edges of the valves and plugs with the cloth.
3. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.
4. On a C6 transmission, inspect the separator plate screen for obstructions. The screen must be clean and free of foreign material. If contaminated, remove it from separator plate, clean in a suitable solvent, and thoroughly blow clean with compressed air.
5. Roll the manual valve on a flat surface to check for bent condition.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Soft/early/mushy 2-3 upshift.	1. For 7.3L Diesel, C6 application — VRV.	1. Check VRV for 7.3L Diesel, C6 application.
	2. Valve body bolts loose/too tight.	2. Tighten to specification.
	3. Valve body dirty/sticking valves.	3. Determine source of contamination. Service as required.
	4. AOD ONLY — Direct clutch assembly or reverse/high clutch/burnt worn.	4. Stall test. Determine cause of condition. Service as required.
	5. Vacuum diaphragm or TV control rod bent, sticking, leaks.	5. Check diaphragm and rod. Replace as necessary.
	6. Vacuum regulator valve misadjusted or damaged. (C-6 with 7.3L Diesel).	6. Check adjustment and function. Adjust or replace.
AOD ONLY — No. 3-4 upshift (stays in 3rd gear).	1. Direct clutch circuit leakage. NOTE: Direct clutch plates burnt will help to confirm leakage in the direct clutch circuit. Replacing only the plates and not finding the cause will result in a repeat repair.	1. Perform Direct Clutch Pressure Test. • Check torque on valve body bolts. Torque not to spec. (loose); can cause leakage. • Check for nicks or porosity in the case passages. (Valve body to case mating surface.) Replace case for the above. • Direct clutch piston check ball leaking. Perform check ball leakage procedure; found in cleaning and inspection portion. Replace piston if leakage confirmed. • Direct clutch piston seal rings (inner and outer) leaking. Replace. • Check the direct clutch output shaft seal rings (#5, #6). They should move freely on the output shaft. Check for metal shaving contamination or burrs between the seal and the output shaft. Replace as necessary. • Check the large seal rings on the output shaft for freedom of movement. Check for contamination such as metal shavings on the output shaft. Replace as necessary. NOTE: The four large seal rings are numbered #7, #8, #9, #10. Seal rings #7, #8 (closest to the output shaft hub) are for the direct clutch. Seal rings #9, #10 (closest to the governor) are for the governor. • Inspect the output shaft feed passages and the cup plug for leakage.
	2. Valve body contamination/sticking valves.	2. Clean the valve body. Check for sticking valves as follows: Overdrive servo regulator valve; 3-4 shift valve; 3-4 TV modulator valve; orifice control valve. If any valves are sticking and they cannot be freed, replace valve body.

CD4919-2C

Intermediate Servo

C6

1. Inspect the servo bore for cracks and the servo piston for damage, and the piston bore and the servo piston stem for scores. Check fluid passages for obstructions. Replace damaged seals.
2. Check the servo spring and servo band strut(s) for distortion.
3. Inspect the cover seal and gasket cover sealing surface for damage.

Low-Reverse Servo

AOD

1. Inspect the servo body for cracks and the piston bore for scores.
2. Check the fluid passages for obstructions.
3. Inspect the band and the struts for distortion. Inspect the band ends for cracks.
4. Inspect the servo spring for distortion.

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
AOD Only — No. 3-4 upshift (stays in 3rd gear) (continued).	3. Main control gasket distortion.	3. Check to see if main control gasket is blocking an orifice. Replace gasket.
	4. Case being out-of-flat can cause sticking valve.	4. Reduce valve body bolt torque to minimum side of spec. 80 in-lbs.
	5. Governor leakage.	5. Check last two large seal rings on the output shaft (#9, #10). They should move freely. Check for metal shaving contamination or burrs between the seal and output shaft. Replace as necessary. • Check the seal ring bore at the rear of case for scoring. Light scoring is permissible. Deep grooving indicates case wear. Replace case for deep grooving. • Check the governor to output shaft retaining ring to make sure it is properly seated on the output shaft. Repair as necessary. • Check the fit of the governor counterweight on the output shaft. If the fit is sloppy, replace the counterweight.
AOD Only — Harsh/delayed 3-4 upshift.	1. Valve body bolts — loose/too tight.	1. Tighten to specification.
	2. Valve body dirty/sticking valves.	2. Determine source of contamination. Service as required.
	3. Incorrect engine performance.	3. Tune, adjust engine idle as required.
	4. 3-4 accumulator piston seals worn/cut.	4. Determine cause of condition. Service as required.
	5. 3-4 accumulator piston apply passage blocked.	5. Determine cause of condition. Service as required.
Slipping 4th gear (engine flare-up/no 4th gear drive capability).	1. Overdrive circuit leakage or blocked passage. NOTE: Burnt overdrive band will help to confirm leakage in the overdrive circuit. Replacing only the overdrive band without finding the cause will result in a repeat repair.	1. Check valve body bolt torque. Torque not to spec. (loose); can cause leakage. Spec. is 80-100 in-lbs. • Overdrive servo cover O-rings leaking. Replace O-rings. • Overdrive servo piston seal leaking. Replace seal. • Overdrive servo cover cracked/ porous. Coat cover with fluid. Apply air to overdrive servo, apply passage using tool (T80L-77030-B). Observe to see if air bubbles are present on overdrive servo cover. Replace cover if air bubbles are present.
	2. Overdrive servo piston not applying overdrive band/band not applying.	2. Overdrive servo case apply passage blocked. Air pressure test. Replace case if necessary.
	3. Overdrive band mislocated.	3. Overdrive servo piston not seated to the band end seat. Repair. • Overdrive band not seated to anchor pin. Repair.
	4. Converter damper plate and hub fracturing, the weld and/or rivets fatiguing, or the damper springs breaking.	4. Perform converter damper/hub assembly weld check procedure. Use special service tools T83L-7902-A. Replace converter if shaft turns more than two degrees or if there is a grinding noise while applying 50 lbs. ft. torque.
	5. Direct driveshaft splines distorted.	5. Check splines on both ends of the direct driveshaft. Check splines in direct clutch cylinder. Replace direct driveshaft and hardware that splines to it for distortion.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Erratic shifts.	1. Poor engine performance.	1. Check engine tune-up.
	2. TV cable — binding/sticking (AOD).	2. Inspect throttle linkage. Service as required. Check VRV for 7.3L Diesel, C6 application.
	3. Valve body bolts — loose/too tight.	3. Tighten to specification.
	4. Valve body dirty/sticking valves.	4. Line pressure test, note results. Determine source of contamination. Service as required.
	5. Governor valve stuck.	5. Perform governor test. Service as required.
	6. Output shaft collector body seal rings damaged.	6. Service as required.
Shifts 1-3 in D. (D or Ⓓ range for AOD).	1. Intermediate band out of adjustment (C6).	1. Adjust band.
	2. Intermediate friction clutch burnt/ damaged (AOD).	2. Determine cause of condition. Service as required.
	3. Intermediate one-way clutch damaged (AOD).	3. Determine cause of condition. Replace/ service as required.
	4. Damaged intermediate servo and/or internal leaks (C6).	4. Perform air pressure test. Service front servo and/or internal leaks.
	5. Improper band or clutch application, or oil pressure control system.	5. Perform control pressure test.
	6. Polished, glazed band or drum (C6).	6. Service or replace band or drum.
	7. Dirty or sticking valve body.	7. Clean, service or replace valve body.
	8. Governor valve stuck.	8. Perform governor test. Service as required.
Engine over-speeds on 2-3 shift.	1. Linkage out of adjustment.	1. Service or adjust linkage. Check VRV for 7.3L Diesel, C6 application.
	2. Improper band or clutch application, or oil pressure control system.	2. Perform control pressure test.
	3. Intermediate servo piston seals cut/ leaking.	3. Replace seals. Check for leaks.
	4. Dirty or sticking valve body.	4. Clean, service or replace valve body.
	5. Converter damper/hub brake (AOD).	5. Perform converter damper/hub weld check. Replace converter if necessary.
AOD Only — Shift hunting 3-4, 4-3.	1. Poor engine performance — EGR solenoid defective.	1. Tune-up engine — Replace solenoid.
	2. Manual linkage misadjusted.	2. Check and adjust or service as required.
Rough/shudder 3-1 shift at closed throttle in D. (D range for AOD).	1. Incorrect engine idle or performance.	1. Tune, and adjust engine idle.
	2. Improper linkage adjustment.	2. Service or adjust linkage. Check VRV for 7.3L Diesel, C6 application.
	3. Improper clutch or band application or oil pressure control system.	3. Perform control pressure test.
	4. Improper governor operation.	4. Perform governor test. Service as required.
	5. Dirty or sticking valve body.	5. Clean, service or replace valve body.
AOD Only — Rough or mushy 4-2 or 3-1 shift.	1. Incorrect engine performance.	1. Tune, adjust engine idle as required.
	2. Improper throttle or manual linkage adjustment.	2. Service or adjust linkage.
	3. Improper application of intermediate friction and one way clutch.	3. Service as required.
	4. Dirty or sticking valve body.	4. Clean, service or replace valve body.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
No forced downshifts.	1. Kickdown linkage out of adjustment (C6).	1. Service or adjust linkage.
	2. Damaged internal kickdown linkage (C6).	2. Service internal kickdown linkage.
	3. Damaged, misadjusted (long) TV cable (AOD).	3. Inspect and adjust TV cable.
	4. Improper clutch or band application, or oil pressure control system.	4. Perform control pressure test.
	5. Dirty or sticking governor.	5. Perform governor test. Service or replace governor, clean screen.
	6. Dirty or sticking valve body.	6. Clean, service, or replace valve body.
Engine over-speeds on 3-2 downshift (C5).	1. Linkage out of adjustment.	1. Service or adjust linkage. Check VRV for 7.3L Diesel, C6 application.
	2. Intermediate band out of adjustment.	2. Adjust intermediate band.
	3. Improper band or clutch application, and one way clutch, or oil pressure control system.	3. Perform control pressure test service clutch.
	4. Damaged or worn intermediate servo.	4. Air pressure test check the intermediate servo. Service servo and/ or seals.
	5. Polished, glazed band or drum.	5. Service or replace as required.
	6. Dirty or sticking valve body.	6. Clean, service or replace valve body.
Shift efforts high.	1. Manual shift linkage damaged/ misadjusted.	1. Check and adjust or service as required.
	2. Inner manual lever nut loose.	2. Tighten nut to specification.
	3. Manual lever retainer pin damaged.	3. Adjust linkage and install new pin.
Transmission overheats.	1. Improper fluid level.	1. Perform fluid level check.
	2. Incorrect engine idle, or performance.	2. Tune, or adjust engine idle.
	3. Improper clutch or band application, or oil pressure control system.	3. Perform control pressure test.
	4. Restriction in cooler or lines.	4. Service restriction.
	5. Seized converter one-way clutch.	5. Replace one-way clutch.
	6. Dirty or sticking valve body.	6. Clean, service or replace valve body.
Transmission clunk or squawk during 1-2 or 2-3 shift (AOD).	1. Intermediate clutch piston bleed hole blocked or not positioned at 12 o'clock.	1. Clean piston and install bleed hole at 12 o'clock position.
	2. Anti-clunk spring not positioned.	2. Secure anti-clunk spring.
	3. Converter damper spring broken.	3. Perform converter damper hub weld check.
Transmission leaks.	1. Case breather vent.	1. Check the vent for free breathing. Repair as required.
	2. Leakage at gasket, seals, etc.	2. Remove all traces of lube on exposed surfaces of transmission. Check the vent for free breathing. Operate transmission at normal temperatures and perform fluid leakage check. Service as required.
Poor vehicle acceleration.	1. Poor engine performance.	1. Check engine tune up.
	2. Torque converter one-way clutch locked up.	2. Replace torque converter.
Transmission noisy — valve resonance.	1. Improper fluid level.	1. Perform fluid level check.
	2. Linkage out of adjustment.	2. Service or adjust linkage.
	3. Improper band or clutch application, or oil pressure control system.	3. Perform control pressure test.
NOTE: Gages may aggravate any hydraulic resonance. Remove gage and check for resonance level.	4. Cooler lines grounding.	4. Free up cooler lines.
	5. Dirty or sticking valve body.	5. Clean, service or replace valve body.
	6. Internal leakage or pump cavitation.	6. Service as required.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
AOD only, harsh coasting downshift clunk.	1. Anti-clunk spring not seated properly. 2. TV cable misadjusted (short).	1. Re-position anti-clunk spring properly. 2. Adjust TV cable, repair as required.
AOD only, initial engagement clunk (engine warm). NOTE: Refer also to rough initial engagement.	1. Engine RPM's above specification. 2. TV cable misadjusted. 3. Worn/damaged/loose. A. U-joint (front/rear) B. Slip yoke C. Rear axle D. Rear suspension 4. Excessive transmission end play.	1. Adjust engine RPM's to specification. 2. Adjust TV cable. 3. Service as necessary. 4. Check transmission end play according to shop manual procedure in Section 17-20. Replace selective thrust washer if necessary.
Vehicle will not start.*	1. Misadjusted neutral start switch (C6). 2. Misadjusted ignition switch. 3. Defective ignition switch. 4. Defective neutral start switch.	1. Adjust neutral start switch (C6). 2. Adjust ignition switch. 3. Replace ignition switch. 4. Replace neutral switch.

*For 7.3L Diesel Engines equipped with C6 Transmission, refer to the appropriate portion of Group 28 for additional information.

CD4817-2E

5. Inspect the band lining for excessive wear and bonding to the metal band.
6. Replace damaged seals.

Overdrive Servo

AOD

1. Inspect the servo cover for cracks and the piston bore for scores.
2. Check the fluid passages for obstructions.
3. Inspect the band for wear or damage. The apply rod should be securely attached to the piston.
4. Inspect the servo spring for distortion.
5. Inspect the band lining for excessive wear and bonding to the metal band.
6. Replace damaged seals.

Extension Housing

1. Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage.
2. Inspect the bushing for scores or wear. Replace if required.
3. Inspect the rear seal for hardness, cracks, or wear. If the seal shows wear or deterioration, replace the seal.
4. Inspect the seal counterbore and remove all burrs and scores with crocus cloth.

Governor

1. Inspect the governor valves and bores for scores. Minor scores may be removed from the valves with crocus cloth. Replace the governor if the valves or body is deeply scored.
2. On AOD transmission, inspect the governor screen for obstructions. The screen must be free of foreign material. If contaminated, clean thoroughly in a suitable solvent and blow dry with compressed air.
3. Check for free movement of the valves in the bores. The valves should slide freely of their own weight in the bores when dry. Inspect fluid passages in the valve body and counterweight for obstructions. **All fluid passages must be clean.**
4. Inspect the mating surfaces of the governor body and governor distributor (C6) for burrs and distortion. Mating surfaces must be smooth and flat.
5. Check the mating surface of the governor valve and the counterweight on Automatic Overdrive transmission for burrs or scratches.

Front Pump

1. Inspect the mating surfaces of the pump body and case for burrs.
2. Inspect the drive and driven gear bearing surface for scores and check gear teeth for burrs.
3. Inspect the front pump seal for cuts or nicks, and the pump bushing for scoring.
4. Check the fluid passages for obstructions.
5. If any parts are found damaged or worn, replace the pump as a unit. Minor burrs and scores may be removed with crocus cloth.

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TRANSMISSION NOISY — OTHER THAN VALVE RESONANCE

	TEST STEP	RESULT	ACTION TO TAKE
1	VERIFY NOISE		
	• Check for gear noise to verify if within normal range.	Noise within normal range (OK) ▶	Normal condition.
		Noise not within normal range (OK) ▶	GO to **2.**
2	LINKAGE CHECK		
	• Check linkage for proper adjustment, wear or damage.	(OK) ▶	GO to **3.**
		(OK) ▶	SERVICE, REPLACE and/or ADJUST linkage as required.
3	FLUID CHECK		
	• Check the fluid for proper level and/or contamination. ①	Fluid level between ADD and FULL marks (OK) ▶	GO to **4.**
		Fluid level beneath ADD mark (OK) ▶	ADD specified fluid to bring level between ADD and FULL marks with vehicle at operating temperature. GO to **4.**
		Fluid contaminated (OK) ▶	DISASSEMBLE, CLEAN and SERVICE transmission. FLUSH torque converter and cooler.
4	STALL TEST		
	• Perform the Stall Test as described under Stall Test in the Diagnosis and Testing portion of this section.	Noise stops (OK) ▶	GO to **5.**
		Noise doesn't stop (OK) ▶	EXAMINE torque converter and pump. SERVICE or REPLACE as required. Also CHECK for loose torque converter to flywheel housing bolts or nuts.
5	NOISE CHECK		
	• Run transmission in all gears and check for noise.	Noise doesn't stop in any gear ▶	GO to **6.**
		Noise stops in Low and R only ▶	SERVICE front planetary and/or one-way clutch.
		Noise stops in 2, HIGH and R only ▶	SERVICE rear planetary.
		HIGH only ▶	SERVICE both planetaries.
6	SPEEDOMETER GEAR		
	• Remove the speedometer gear and check for noise.	Noise stops ▶	REPLACE speedometer gear.
		Noise doesn't stop ▶	CHECK extension housing bushing, seal or driveshaft. SERVICE or REPLACE as required.

NOTE: AOD transmission has only one gear set. Gear noise requires the replacement of the planetary carrier assembly.

①For definition of contamination, refer to Transmission Fluid Condition Check in the Diagnosis and Testing portion of this section.

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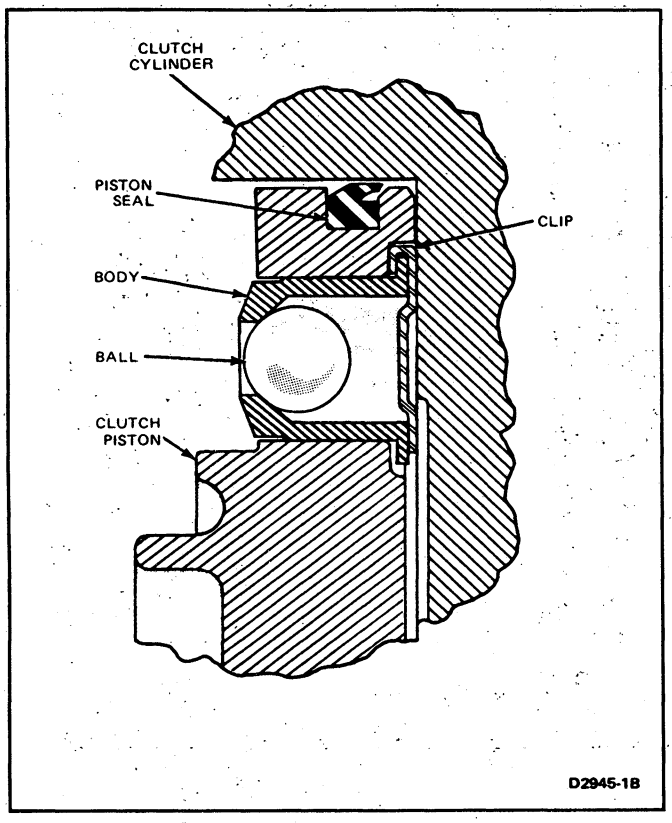


FIG. 29 Clutch Piston Check Ball

6. On a C6 and AOD transmission, check the large seal ring groove of the pump body for damage. Check the gasket mating surface of the pump body for damage.

Reverse-High Clutch—C6—Reverse Clutch—AOD

1. Inspect the drum band surface, the bushing, and thrust surfaces for scores. Minor scores may be removed with crocus cloth. **Badly scored parts must be replaced.**
2. Inspect the clutch piston bore and the piston inner and outer bearing surfaces for scores. Check the air bleed ball valve in the clutch piston for free movement. Check the orifice to make sure it is not plugged.
3. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.
4. Inspect the clutch plates for wear, scoring, and fit on the clutch hub serrations. Replace all plates that are badly scored, worn, or do not fit freely in the hub serrations.
5. Inspect the clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release spring(s) for distortion.
6. The clutch piston has a check ball similar to Fig. 29. Inspect the check ball for freedom of movement and proper seating.

Forward Clutch

1. Inspect the clutch cylinder thrust surfaces, piston bore, and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating (Fig. 29). AOD—Check both check balls in the forward clutch cylinder for freedom of motion.
3. Check the clutch release spring (C6 only) for distortion and cracks. Replace the spring if distorted or cracked.
4. Inspect the composition clutch plates, steel clutch plates, and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
5. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.
6. Check the splines on the stator support for wear. Inspect the bushing in the stator support for scores. Check the input shaft (C6) for damaged or worn splines. Replace shaft if the splines are excessively worn.

Direct Clutch—AOD

1. Inspect the clutch cylinder thrust surfaces, piston bore, and clutch plate splines for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating (Fig. 29). Perform the Direct Clutch Piston Check Ball Leakage procedure.
3. Check the clutch release springs and retainer for distortion and cracks. Replace the springs and retainer if distorted or cracked.
4. Inspect the friction clutch plates, steel clutch plates, and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored or polished.
5. Check the clutch plates for flatness and fit on the clutch hub splines. Discard any plate that does not slide freely on the splines or that is not flat.
6. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.
7. Check the splines on the direct drive shaft for wear, replace the shaft if the splines are excessively worn.

Direct Clutch Piston Check Ball Leakage Procedure

Direct clutch piston check ball—Inspect the piston check ball for freedom of movement. Improper seating of check ball will cause leakage. Leakage can be detected by turning the piston upside down (flat side of piston facing you) allowing the check ball to seat in the piston. Pour a small quantity of solvent over the check ball. If solvent drips past the check ball, replace the piston.

Low—Reverse Clutch—C6

1. Inspect the clutch cylinder piston bore and clutch plate serrations for scores or burrs. Minor scores or

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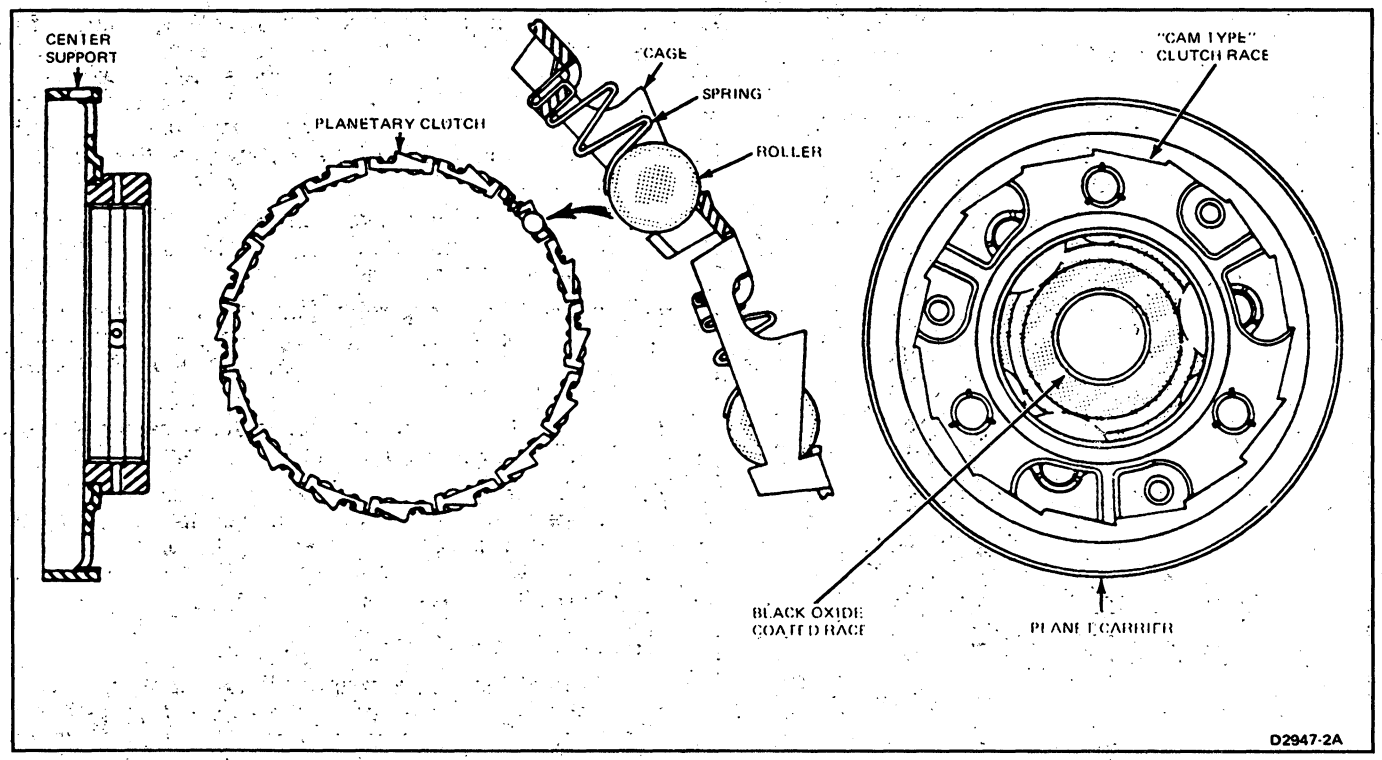


FIG. 30 Roller Type Planetary Clutch, Carrier and Center Support—AOD

burrs may be removed with crocus cloth. Replace the case if it is badly scored or damaged.

2. Check the fluid passage in the case for obstructions (Fig. 16). Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary.
3. Check the piston return springs for distortion. Check the piston return spring retainer for flatness.
4. Inspect the composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
5. Check the clutch hub splines.

Intermediate Clutch—AOD

1. Inspect the piston bore in the rear of the pump body for scores or burrs. Minor damage can be repaired with a crocus cloth.
2. Check and clean all fluid passages in the case and pump and the piston. Inspect both lip seals and replace if damaged.

   NOTE: Upon reassembly the small drilled hole in the piston must be located toward the top of the transmission (12 o'clock position).
3. Check the springs and spring retainer for damage. Note how the retainer is held to the body with tabs.
4. Inspect composition clutch plates, steel clutch plates and pressure plate. Replace any badly worn or scored parts.

Planetary One-Way Clutch

1. Inspect the intermediate outer and inner races for scores or damaged surface areas where rollers contact the races. If the intermediate one-way clutch inner race on the AOD transmission is damaged, the reverse clutch drum must be replaced.
2. Inspect the rollers and springs for excessive wear or damage.
3. Inspect the spring and roller cage for bent or damaged spring retainers.

Planet Carrier and Center Support (AOD)

1. Inspect the clutch outer race, inner race, band surface, pinion gears, bearings, and thrust washer (Fig. 30) for roughness.
2. Inspect the center support bushing for roughness.
3. Inspect one way clutch, springs, rollers and springs.

Converter and Fluid Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and MUST be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter and oil cooler MUST be cleaned by using the Rotunda torque Converter Cleaner (model 014-00028) or equivalent. Under NO circumstances should an attempt be made to clean converters by hand agitation with solvent.

Converter End Play and One Way Clutch Check

The Tools T76L-7902-C and T77L-7902-R shown in Fig. 31 are used to check the converter one-way clutch.

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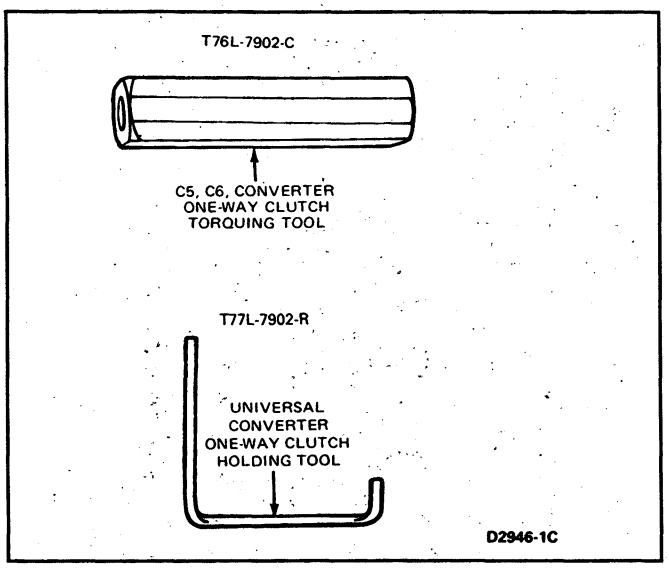


FIG. 31 Converter One Way Clutch Check Tools

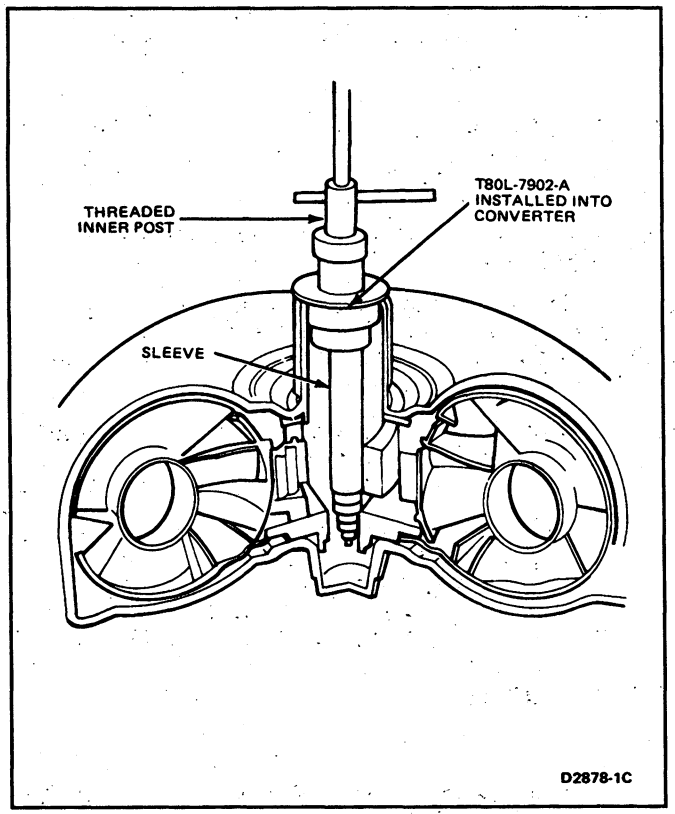


FIG. 32 End Play Checking Tool Installed

End Play Check

1. Insert Tool T80L-7902-A into the converter pump drive hub until it bottoms (Fig. 32).
2. Expand the sleeve in the turbine spline by tightening the threaded inner post, (Fig. 32), until the tool is securely locked into the spline.
3. Attach a dial indicator (with bracketry) TOOL-4201-C to the tool (Fig. 33). Position the indicator button on the converter pump drive hub, and set the dial face at 0 (zero).
4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the converter unit if the total end play exceeds the limits. End play specifications are listed at the end in the specifications section of this Section.
5. Loosen the threaded inner post to free the tool, and then remove the tool from the converter.

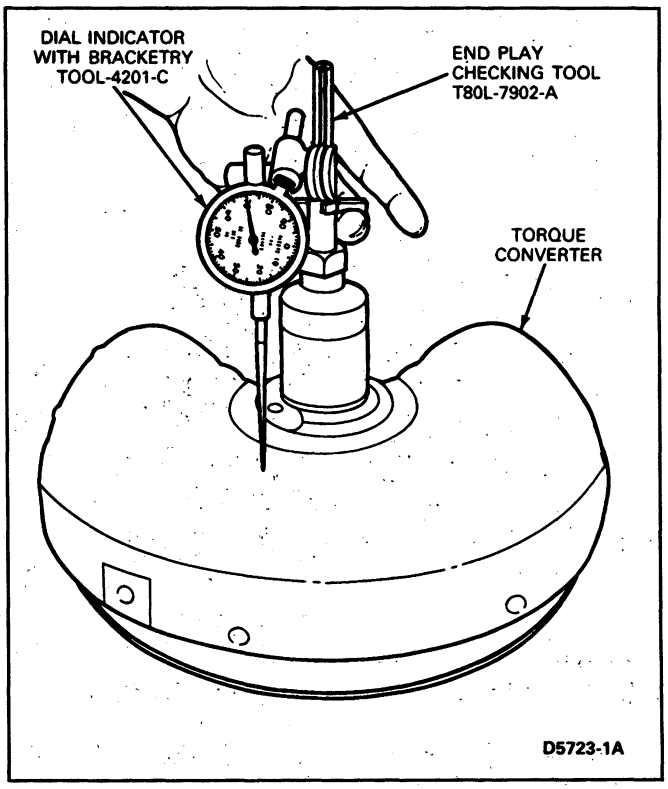


FIG. 33 Checking Stator and Turbine End Play

Converter One-Way Clutch Check

1. Insert the one way clutch holding Tool T77L-7902-R (Fig. 34), in one of the grooves in the stator thrust washer.
2. Insert the one way clutch torquing Tool, (T77L-7902-B) in the converter pump drive hub so as to engage the one way clutch inner race, (Fig. 34).
3. Attach a torque wrench to the one way clutch torquing tool. With the one way clutch holding tool held stationary, turn the torque wrench counterclockwise. The converter one way clutch should lockup and hold a 14 N·m (10 ft-lbs) force. The converter one way clutch should rotate freely in a clockwise direction. Try the clutch for lockup and hold in at least five different locations around the converter.
4. If the clutch fails to lock up and hold at 14 N·m (10 ft-lbs) torque, replace the converter unit.

Converter Damper/Hub Weld Check—AOD Only

Refer Fig. 35.

1. Position the holding fixture Tool T83L-7902-A3 in a vise and clamp tight.
2. Place the converter on top of the holding fixture aligning the pilot hub and one stud in the appropriate holes.

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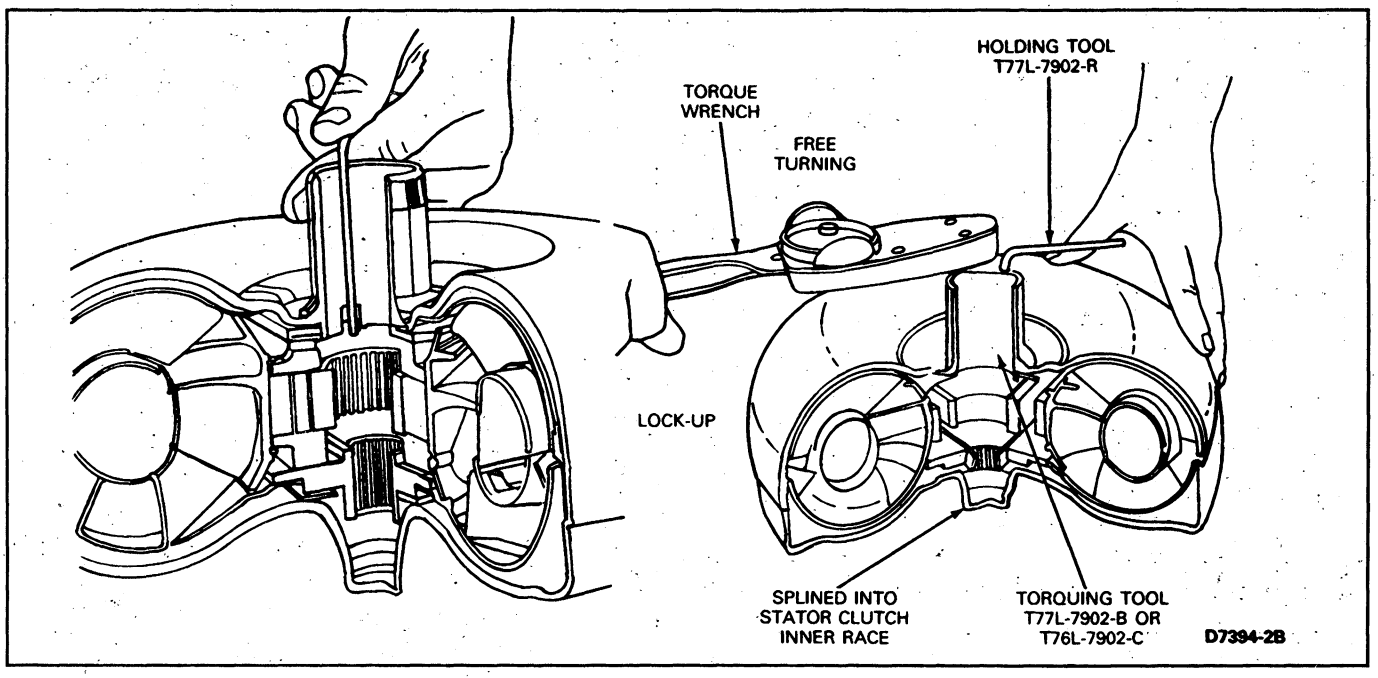


FIG. 34 Checking Converter One-Way Clutch

3. Spline the torque adapter turning Tool T83L-7902-A1 into the converter, making sure the splines engage the damper assembly.
4. Install the pilot guide Tool T83L-7902-A2 over the torque adapter turning tool and onto the impeller hub.
5. HOLD the converter snug to the holding fixture with one hand when applying torque.
6. Turn the shaft clockwise and counterclockwise applying approximately 67 N·m (50 ft-lbs) torque with a 3/4 inch drive socket and torque wrench.
7. The shaft should not turn more than two degrees.
8. If there is a grinding noise and/or if the shaft turns more than two degrees, the converter damper assembly, welds, rivets, or reaction hub are broken. Replace the torque converter.

Stator to Impeller Interference Check

1. Position the front pump assembly on a bench with the spline end of the stator shaft pointing up (Fig. 36).
2. Mount a converter on the pump with the splines on the one-way clutch inner race engaging the mating splines of the stator support. The converter hub will then engage the pump drive gear.
3. Hold the pump stationary and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.
4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.

Stator to Turbine Interference Check—C6 and AOD Converters

1. Position the converter on the bench front side down.
2. Install a front pump assembly to engage the mating splines of the stator support and stator, and pump drive gear lugs.
3. Install the input shaft, engaging the splines with the turbine hub (Fig. 37).
4. Hold the pump stationary and attempt to rotate the turbine with the input shaft. The turbine should rotate freely in both directions without any signs of interference or scraping noise.
5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

Check the converter crankshaft pilot for nicks or damaged surfaces that could cause interference when installing the converter into the crankshaft. Check the converter front pump drive hub for nicks or sharp edges that would damage the pump seal.

Pinion Carriers

C6 and AOD

Individual parts of the planet carriers are not serviceable.

1. Check the pins and shafts in the planet assemblies for loose fit and/or complete disengagement. Use a new planet assembly if either condition exists. Before installing a planet assembly, the shaft retaining pins should be checked for adequate staking. If necessary, restake the pins before installation. When restaking, the retaining pins must not be driven into the carrier any further than 1.01mm (0.040 inch) below the surface of the carrier.
2. Inspect the pinion gears for damaged or excessively worn teeth.
3. Check for free rotation of the pinion gears.

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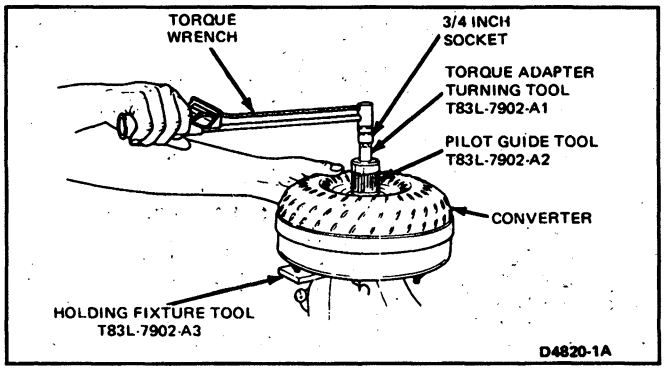


FIG. 35 Converter Damper/Hub Weld Check—AOD

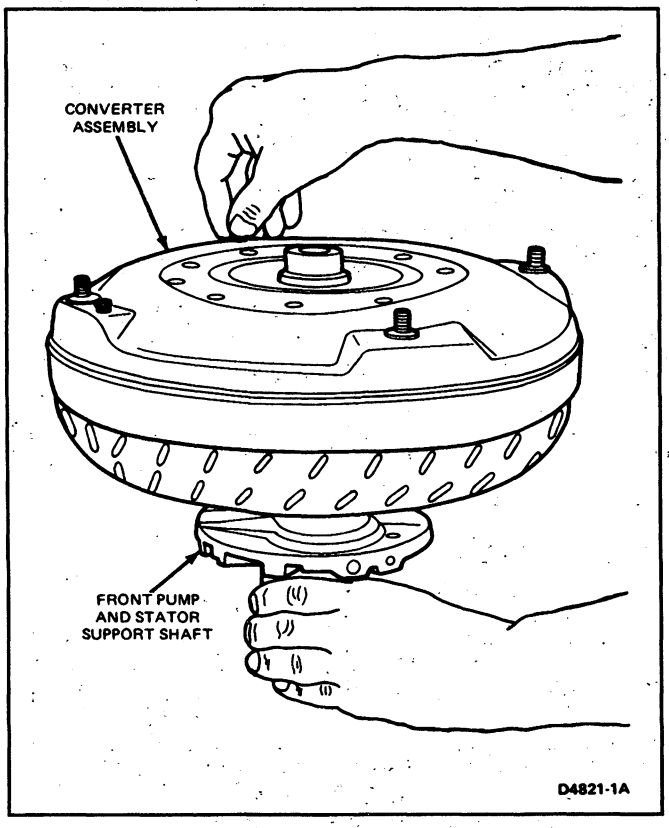


FIG. 36 Stator to Impeller Interference Check

Stator Support

C6 and AOD

1. Inspect the stator support splines for burrs and wear.
2. Check the oil ring grooves in the stator support for nicks, burrs or damaged edges.
3. Check the front and rear bushings of the stator support for wear or scoring.

Case

Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions and leakage (Figs. 15, 16 and 17).

Inspect the case bushing for scores. Check all parking linkage parts for wear or damage.

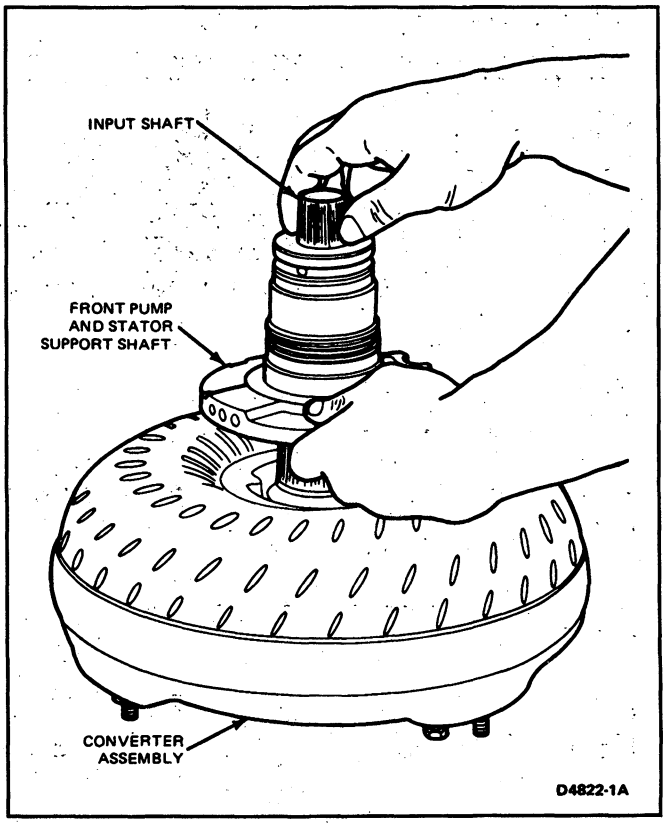


FIG. 37 Stator to Turbine Interference Check—C6 and AOD

If a transmission case thread is damaged, service kits may be purchased from local jobbers. To repair a damaged thread, the following procedures should be carefully followed.

1. Drill out the damaged threads **using the same drill size as the thread outside diameter.** For example, use a 5/16 inch drill for a 5/16-18 thread.
2. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being repaired. Thus, the special tap marked 5/16-18 will not cut the same thread as a standard 5/16-18 tap. The tap cuts a thread large enough to accommodate the insert, and after the insert is installed, the original thread size (5/16-18) is restored.
3. Select the proper coil inserting tool. These tools are marked with the thread size being repaired. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is 1/2 turn below the face.
4. Working through the insert, bend the insert tang straight up and down until it breaks off at the notch.
5. Improperly installed inserts can be removed with the extractor tool. Place the extractor tool in the insert with the blade resting against the top coil 1/4 to 1/2 turn away from the end of the coil. Tap the tool sharply with a hammer until the blade cuts into the insert. Exert downward pressure on the tool and turn counterclockwise until the insert is removed.

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SPECIFICATIONS

VACUUM DIAPHRAGM ASSEMBLY SPECIFICATION

Transmission Type	Diaphragm Type	Diaphragm Part No.	Identification	Throttle Valve Rod #		
				Part No. (7A380)	Length	Identification
C6	HAD	D7AP-7A337-AA	Part No. Stamped	C4AP-A	1.677-1.667	No Color
	SAD	D70P-7A377-BA	1 Green Stripe	D1AP-BA	1.727-1.717	Purple Daub
	SAD	D4TP-7A377-BA	1 Black Stripe	D3AP-DA	1.611-1.601	Yellow Daub
	SAD	D5AP-7A377-AA	1 Purple Stripe	D3AP-EA	1.644-1.634	Blue Daub
				D3AP-FA	1.660-1.650	Green Daub
				D3AP-GA	1.710-1.700	White Daub
				D8AP-AA	1.694-1.684	Brown Daub

Selective fit rods
SAD — Single Area Diaphragm
S-SAD — Super Single Area Diaphragm
HAD — High Altitude Diaphragm

CD2948-2E

AUTOMATIC TRANSMISSION REFILL CAPACITY — C5, C6 AND AOD AUTOMATIC TRANSMISSION

Vehicle	Transmission Type	Engine	Approximate Refill Capacity①		
			U.S. Quarts	Imperial Quarts	Liters
E-150 — E-250 — E-350	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8 7.5L (460 CID) V-8 6.9L Diesel	11-3/4	9.4	11.2
F-150 — F-250 — F-350 (4x2)	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8 7.5L (460 CID) V-8 6.9L Diesel	11-3/4	9.4	11.2
F-150 — F-250 — F-350 (4x4)	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8 7.5L (460 CID) V-8 6.9L Diesel	13-1/2	10.8	12.7
Bronco (4x4)	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8	13-1/2	10.8	12.7
E-150 — E-250 F-150 — F-250 (4x2) (4x4) Bronco (4x4)	AOD②	5.0L (302 CID) V-8 4.9L (300 CID) I-6	12.3	10.2	11.6

①Approximate dry capacity, includes cooler and lines. Fluid level indicator should be used to determine **actual** fluid requirements and fluid specifications. Check level at normal operating temperature. **DO NOT OVERFILL.**

If it is necessary to add or replace fluids, use only fluids which have been certified by the supplier as meeting one of the Ford Motor Company specifications shown below:

②Use Automatic Fluid-Motocraft MERCON® Multi-Purpose Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H).

CD2928-2K

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TORQUE-CONVERTER END-PLAY

Transmission Model	Converter End-Play			
	New or Rebuilt Converter		Used Converter	
	mm	Inch	mm	Inch
C6	0.533 Max.	0.021 Max.	1.01 Max.	0.040 Max.
AOD (Automatic Overdrive)	0.584 Max.	0.023 Max.	1.25 Max.	0.050 Max.

CD2950-2D

STALL SPEED SPECIFICATIONS

Vehicle Application	Engine Disp.	Transmission Type	Converter Size	Stall Speed	
				Min.	Max.
F150/250/350 E150/250/350 Bronco	4.9L	C6	12"	1616	1871
F150/250 E150/250 Bronco	5.0L	C6	12"	1616	1871
F150/250/350 E150/250/350 Bronco	5.8L	C6	12"	1569	1729
F-250/350 E-250/350	7.3L	C6	12"	1715	1966
F-250/350 E-250/350	7.5L	C6	12"	1610	1891
E-Series	4.9L EFI	AOD	12"	2042	2351
F-Series	4.9L EFI	AOD	12"	2042	2351
F-Series/Bronco (4x2, 4x4)	5.0L EFI	AOD	12"	2092	2443
E-Series	5.0L EFI	AOD	12"	2092	2443

CD4824-2F

SPECIAL SERVICE TOOLS

Tool Number	Description
Tool-4201-C	Dial Indicator with Bracketry
Tool-7000-DD	Rubber Tip For Air Nozzle
Tool-7000-DE	Air Nozzle Assembly
T82L-7006-A	Air Pressure Check Plate
T82P-7006-C	Cap Screws for Air Pressure Check Plate
T76L-7902-C	Converter Clutch Torquing Tool
T77L-7902-R	Converter Clutch Holding Tool
T77L-7902-B	Converter Clutch Torquing Tool
T80L-7902-A	Torque Converter End Play Checking Tool
T83L-7902-A	Converter Checking Tool Kit
T83L-7902-A1	Torque Adapter Turning Tool
T83L-7902-A2	Pilot Guide
T83L-7902-A3	Holding Fixture
T80L-77030-B	Servo Piston Remover
T83T-7B200-AH	VRV (Vacuum Regulator Valve) Adjustment Gage Block — C6

ROTUNDA EQUIPMENT

Model	Description
014-00028	Torque Converter Cleaner
021-00054	Torque Converter Leak Tester
014-00737	Automatic Transmission Tester
021-00014	Vacuum Tester
059-00008	Vacuum and Pressure Tester

CD4825-1E

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SECTION 17-02 Shift Control Linkage

SUBJECT	PAGE
ADJUSTMENTS	
Automatic Transmission Manual Linkage Adjustments	17-02-1
Neutral Start Switch Adjustment—C6	17-02-1
DESCRIPTION AND OPERATION	17-02-1
DIAGNOSIS AND TESTING	17-02-1
REMOVAL AND INSTALLATION	
Manual Shift Linkage Grommet	17-02-2
REMOVAL AND INSTALLATION (Cont'd)	
Neutral Start Switch—AOD and E4OD	17-02-4
Neutral Start Switch—C6	17-02-2
SPECIAL SERVICE TOOLS	17-02-9
SPECIFICATIONS	17-02-9
VEHICLE APPLICATION	17-02-1

VEHICLE APPLICATION

Bronco, E-150—E-350, F-150—F-350 (4x2) (4x4), and F-Super Duty Chassis Cab and Motor Home Chassis, Vehicles Equipped with Automatic Transmissions.

DESCRIPTION AND OPERATION

The transmission shift control linkage transfers the selected transmission operating mode from the selector lever to the transmission. The indicated transmission position on the steering column is transferred to a shift lever on the bottom of the steering column. The shift rod transfers this position through the bell crank assembly to the control rod. The control rod transfers the indicated position to the transmission assembly.

For information on the steering column, refer to Section 13-06, Steering Column-Shift Rod within Tube.

DIAGNOSIS AND TESTING

Refer to Section 17-01, General Automatic Transmission Service for diagnosis and testing procedures and Section 17-09, E4OD, Automatic Transmission.

ADJUSTMENTS

Perform the transmission control linkage adjustments in the order in which they appear in this Section of the manual. Before the linkage is adjusted, the shift lever indicator flag must be checked as detailed in Section 13-06, Steering Column Shift Rod within Tube and Section 13-07, Steering Column—Stripped Chassis Models. Be sure the engine idle speed and anti-stall dashpot are properly adjusted Refer to the Engine/ Emissions Diagnosis Manual for the procedure.

Automatic Transmission Manual Linkage Adjustments

1. With the engine stopped and the parking brake applied, place the transmission selector lever at the steering column in the D (DRIVE position) for C6 applications and in the Ⓓ (OVERDRIVE position) for AOD applications, and hold against the D or Ⓓ stop by applying an eight pound weight to the selector lever knob.
2. Loosen the shift rod adjusting nut at point A (Figs. 1-7).
3. Shift the manual lever at the transmission into the D (DRIVE) position or Ⓓ (OVERDRIVE) position, by moving the lever all the way rearward, then forward two detents.
4. With the selector lever and transmission manual lever in the D or Ⓓ position, tighten the nut at point A to 17-24 N·m (12-18 ft-lbs) torque (Figs. 1-7). Use care to prevent motion between the stud and rod.
5. Remove the eight pound weight from the steering column selector lever knob.
6. Operate the shift lever in all positions to make certain that the manual lever at the transmission is in full detent in all gear ranges. Re-adjust the linkage if required.
7. On F-150—F-250—F-350, F-Super Duty Chassis Cab, Motor Home Chassis and Bronco, recheck for correct operation of the automatic transmission selector indicator (PRND21) or (PRNⒹD1). Refer to Section 13-06, Steering Column-Shift Rod within Tube.

Under no circumstances will it be permissible to adjust linkage in any position other than the D position for C6 applications and Ⓓ position for AOD applications.

Neutral Start Switch Adjustment—C6

1. Apply the parking brake.
2. With the automatic transmission linkage properly adjusted, loosen the two switch attaching bolts (Fig. 8).
3. Place the transmission selector lever in neutral. Rotate the switch and insert the gauge pin (No. 43 drill shank end) into the gauge pin holes of the switch. The gauge pin has to be inserted a full 12.303mm (31/64 inch) into the three holes of the switch (Fig. 8).
4. Tighten the two neutral start switch attaching bolts to 6.2-8.4 N·m (55-75 in-lbs). Remove the gauge pin from the switch.
5. Check the operation of the switch. The back-up lamps should come on when the transmission is in reverse. The vehicle should start only with the transmission lever in PARK or NEUTRAL.

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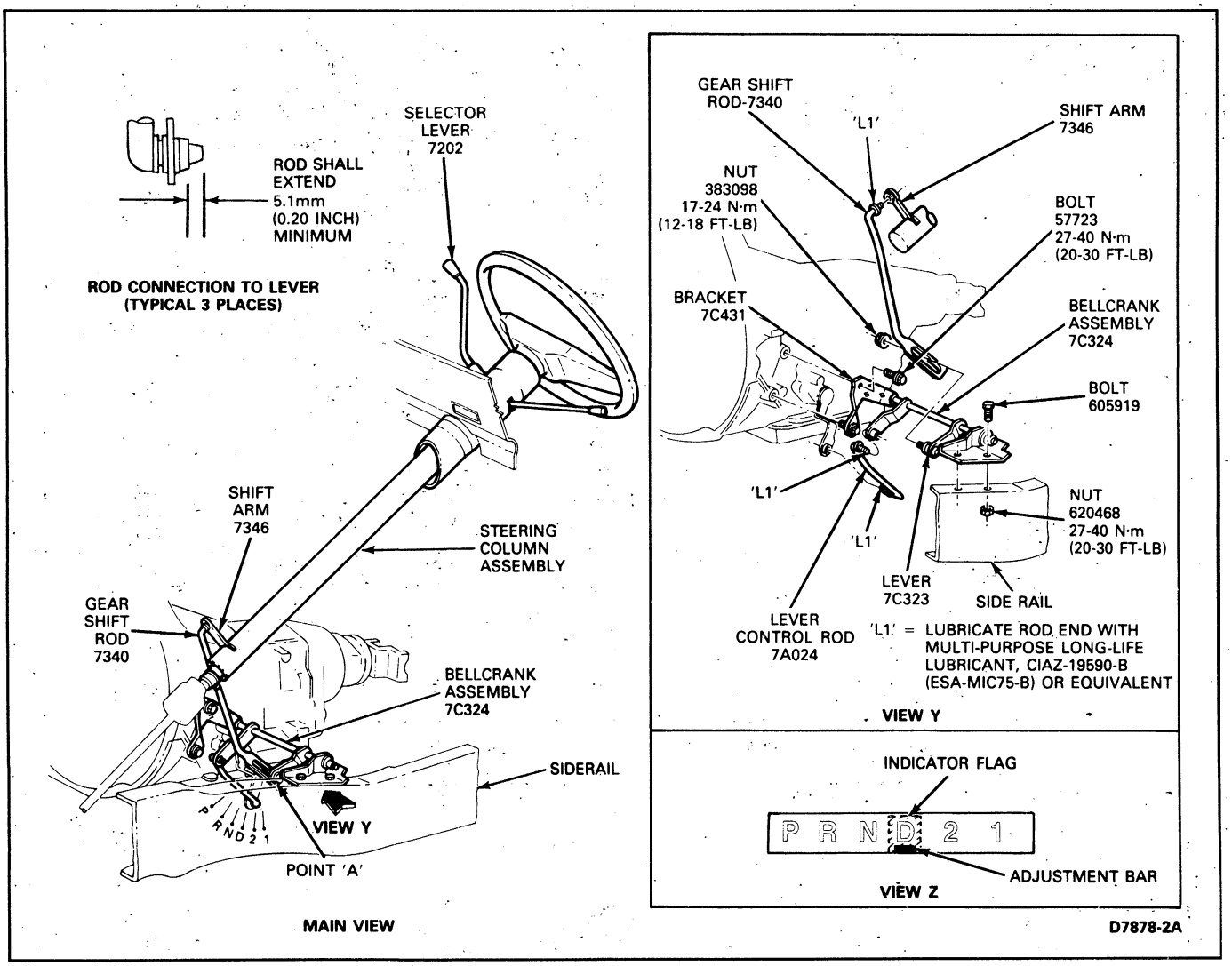


FIG. 1 C6 Automatic Transmission—Shift Linkage Adjustment—F-150—F-350, Bronco

REMOVAL AND INSTALLATION

Manual Shift Linkage Grommet

The automatic transmission linkage systems make use of a polyurethane plastic grommet to connect the various rods, levers and adjusting stud. Whenever a rod is disconnected from a grommet type connector, the old grommet must be removed and a new one installed. Remove and install the grommet as follows:

1. Place the lower jaw of the Shift Linkage Insulation Tool, T67P-7341-A or equivalent between the lever and the rod (Fig. 9). For areas with limited space, use Shift Linkage Grommet Remover, T84P-7341-A or equivalent for removal of the grommet (Fig. 10). Position the stop pin against the end of the control rod (Fig. 9) and force the rod out of the grommet. Remove the grommet from the lever by cutting off the large shoulder with a sharp knife. **The grommet must be removed from the lever and a new one installed each time the rod is disconnected.**
2. Adjust the stop pin to 12.70mm (1/2 inch) and coat the outside of the grommet with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or equivalent. Place a new grommet on the stop pin and force it into the lever hole. Turn the grommet several times to be sure it is properly seated.
3. Readjust the stop pin to the height shown in Fig. 9. The pin height is determined by the length of the rod end which is to be installed into the grommet. If the pin height is not adjusted,the rod may be pushed too far through the grommet causing damage to the grommet retaining lip.

NOTE: Coat ends of rods with D4AZ-19590-A, Linkage Lube or equivalent before installing in new grommet.

4. With the pin height properly adjusted, position the rod on the tool and force the rod into the grommet until the groove in the rod seats on the inner retaining lip of the grommet. For areas with limited space, use Shift Linkage Grommet Replacer, T84P-7341-B or equivalent, for grommet installation (Fig. 10).

Neutral Start Switch—C6

Removal

1. Remove the downshift linkage rod return spring at the low-reverse servo cover.
2. Apply penetrating oil, Rust Penetrant and Inhibitor, D7AZ-19A501-A (ESR-M99C56-A) or equivalent to

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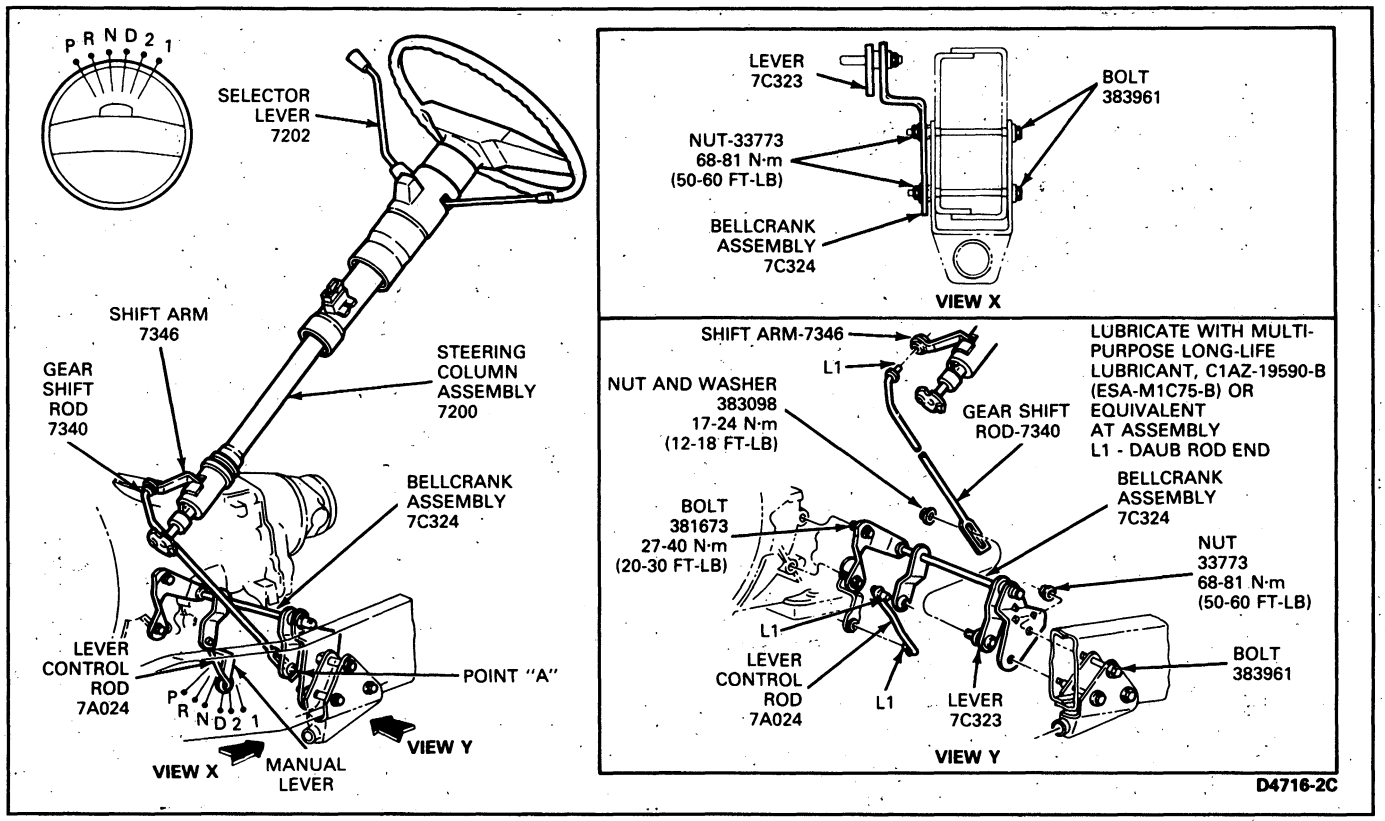


FIG. 2 C6 Automatic Transmission—Shift Linkage Adjustment—E-150—E-350

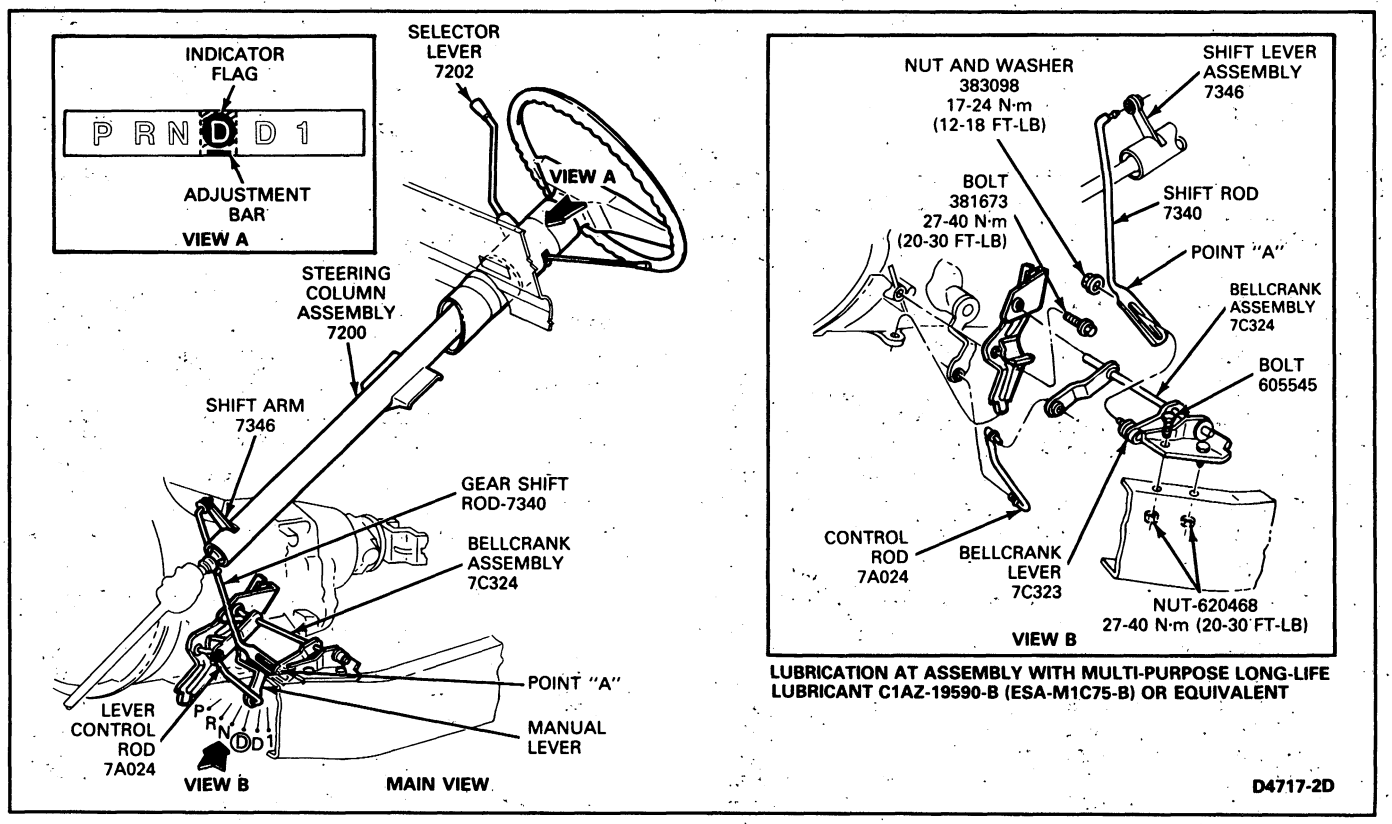


FIG. 3 Shift Linkage—Automatic Overdrive Transmission (AOD)—F-150—F-250 (4x2)

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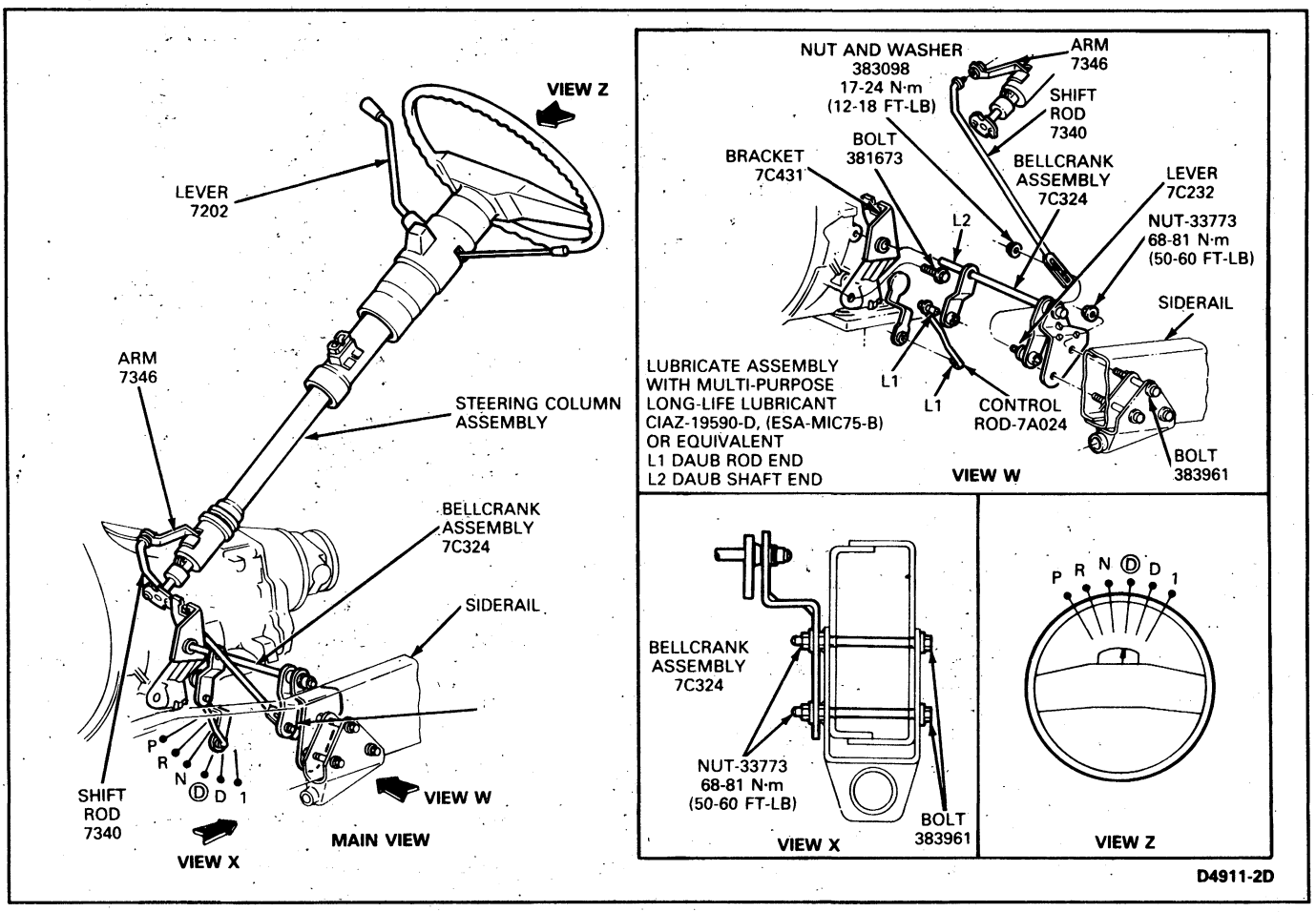


FIG. 4 Shift Linkage Automatic Overdrive Transmission (AOD)—E-150—E-250

the outer lever attaching nut to prevent breaking the inner lever shaft. Remove the transmission downshift outer lever attaching nut and lever.

3. Remove the two neutral start switch retaining bolts (Fig. 8).
4. Disconnect the two multiple wire connectors.
5. Remove the switch from the transmission.

Installation

1. Install the switch on the transmission. Install the two retaining bolts.
2. With the transmission manual lever in neutral, check the location of the switch with the gauge pin. Install gauge pin (No. 43 drill) into the three gauge pin holes (Fig. 8).
3. Tighten the switch attaching bolts to 6.3-8.4 N·m (55-75 in-lbs). Remove the gauge pin.
4. Install the outer downshift lever and retaining nut, and tighten the nut. Install the downshift linkage rod return spring between the lever and retaining clip on the low-reverse servo cover.
5. Connect the wire multiple connectors. The red connector has to be inserted into the red connector and the blue connector inserted into the blue connector. Check the operation of the switch installed. The back up lamps should operate only with the transmission selector lever in REVERSE. The vehicle should start only with the transmission selector lever in PARK and NEUTRAL.

Neutral Start Switch—AOD and E4OD

For neutral start switch removal and installation procedures, refer to Section 17-20, Automatic Overdrive Transmission and Section 17-E4OD, Automatic Transmission.

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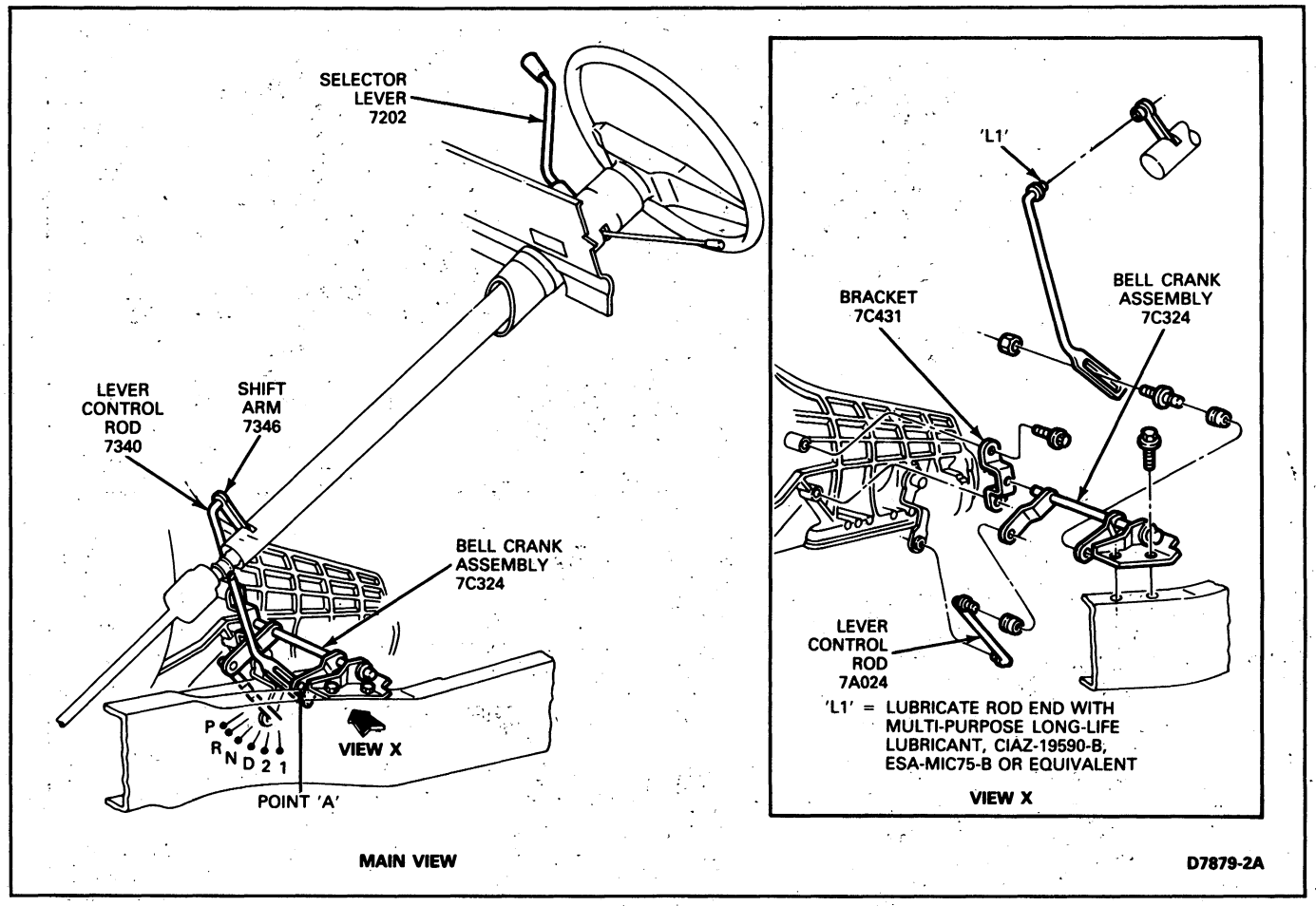


FIG. 5 E4OD Automatic Transmission—Shift Linkage Adjustment—F-150—F-350, Bronco

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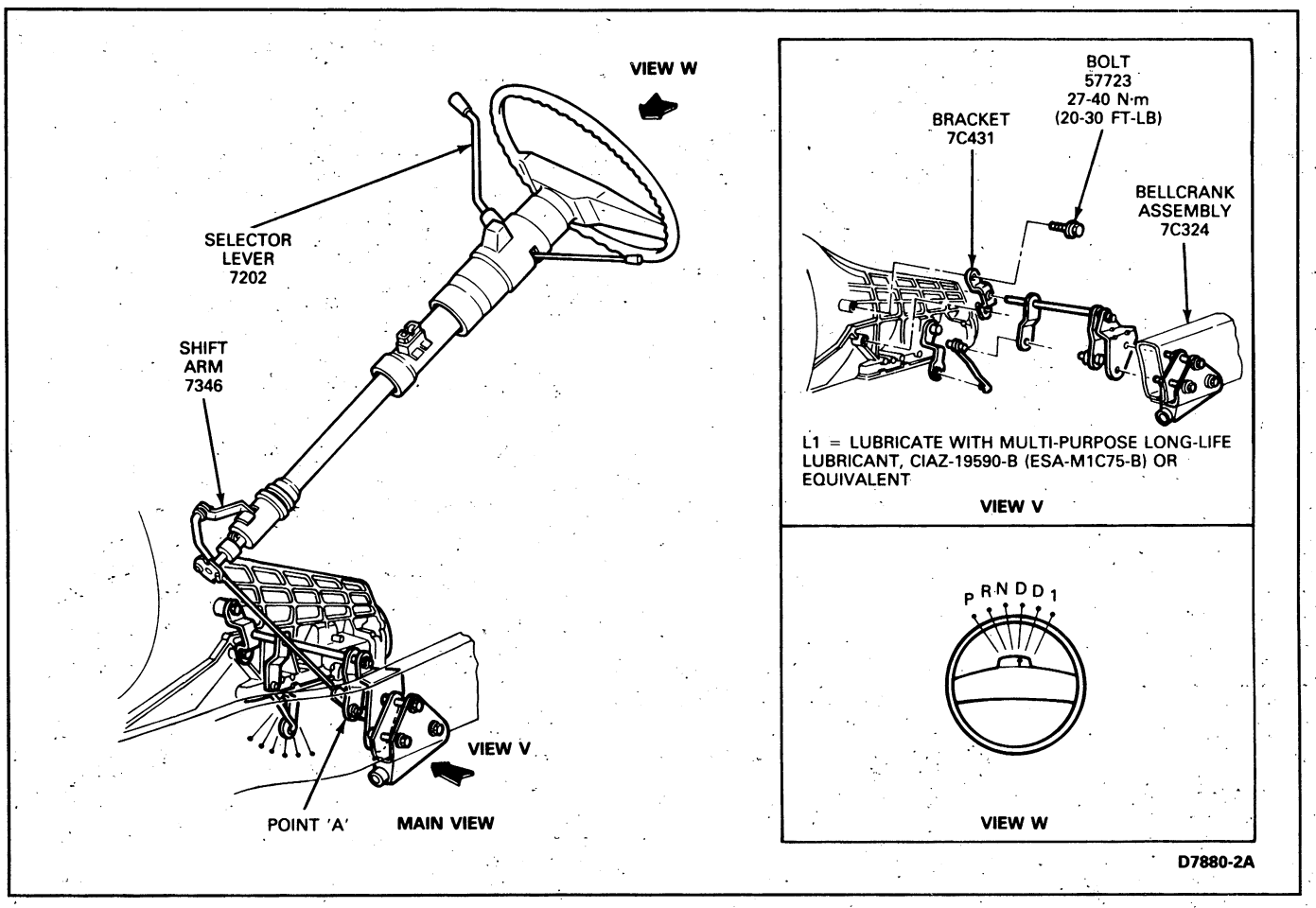


FIG. 6 E4OD Automatic Transmission—Shift Linkage Adjustment—E-150—E-350

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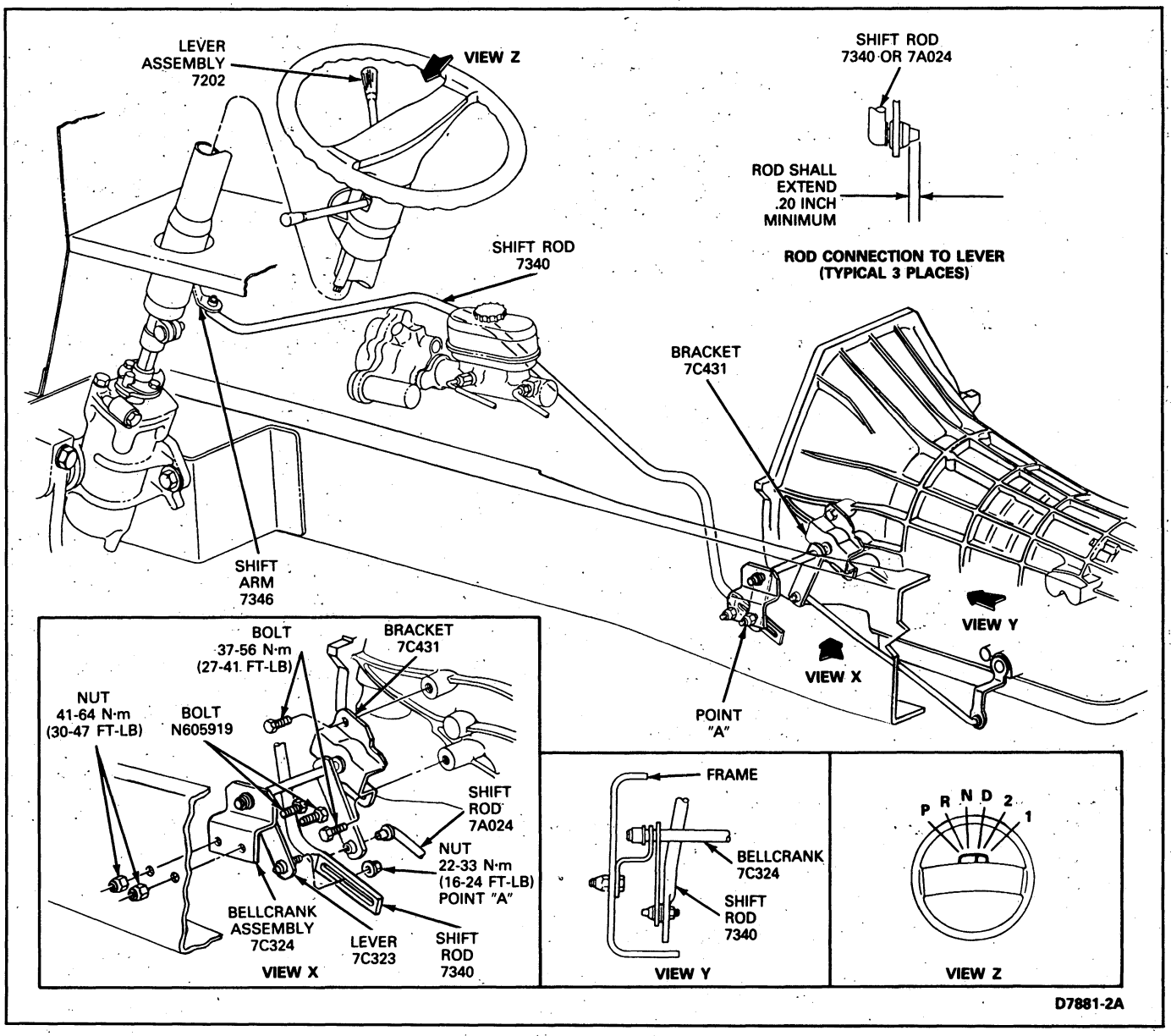


FIG. 7 E4OD Automatic Transmission—Shift Linkage Adjustment—F-Super Duty Motor Home Chassis

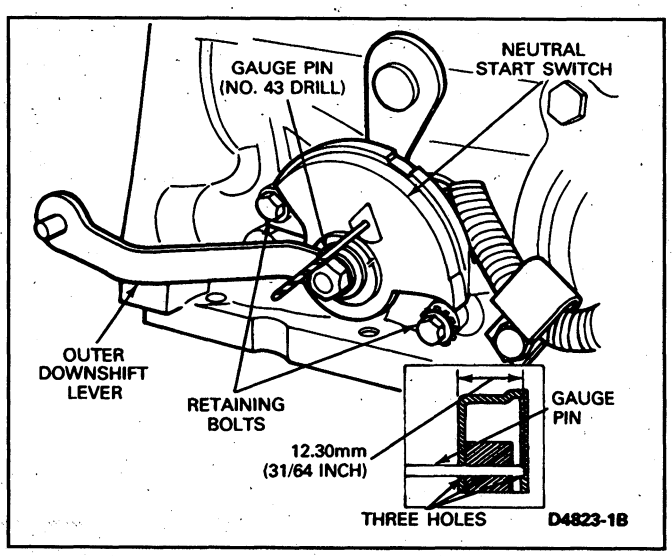


FIG. 8 Neutral Start Switch—C6

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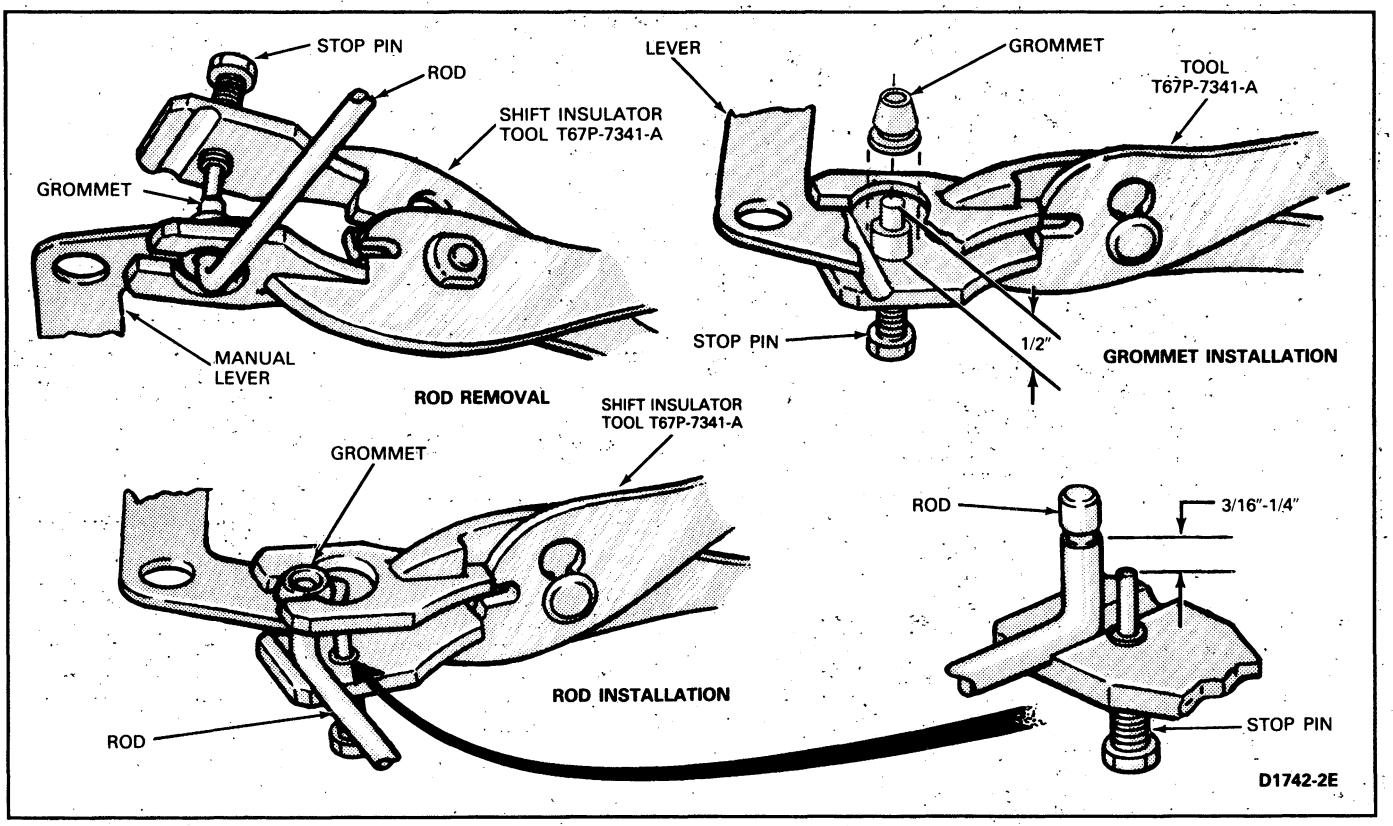


FIG. 9 Removing or Installing Shift Linkage Grommet

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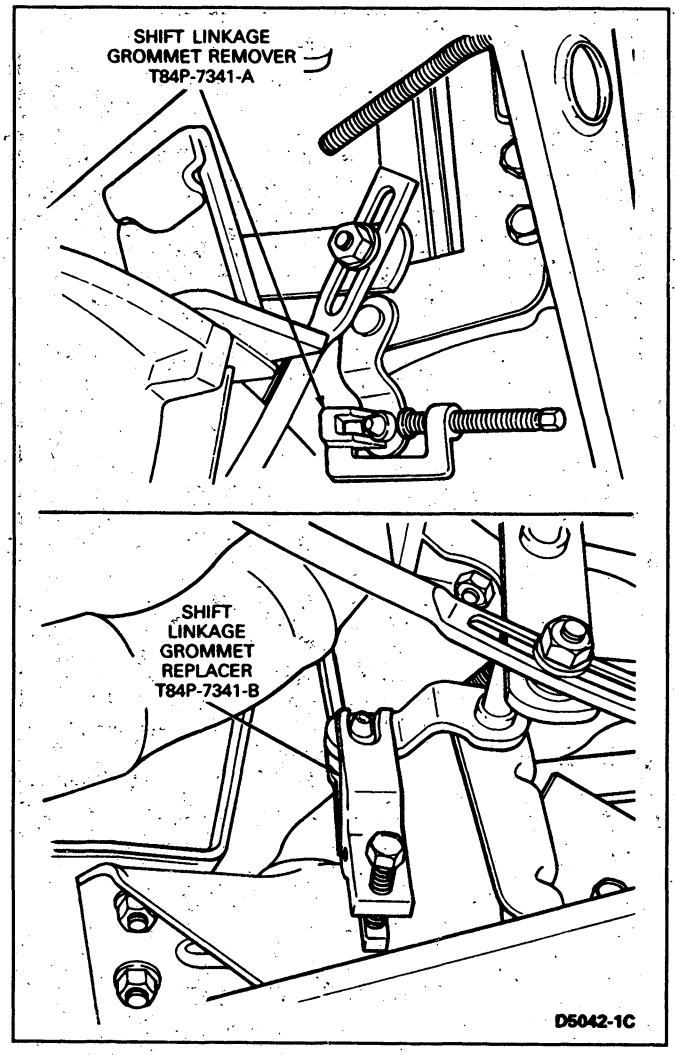


FIG. 10 Removing or Installing Shift Linkage Grommet (Limited Space Situations)

SPECIFICATIONS

TORQUE LIMITS

Description	(in-lbs)	N•m
Neutral Start Switch to Case	55-75	6.3-8.4

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SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS

Number	Description
T67P-7341-A	Shift Linkage Insulation Tool
T74P-77247-A	Neutral Start Switch Socket Tool
T84P-7341-A	Shift Linkage Grommet Remover
T84P-7341-B	Shift Linkage Grommet Replacer

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SECTION 17-09 E4OD Automatic Transmission

SUBJECT	PAGE
ASSEMBLY OF SUBASSEMBLIES	17-09-135
CLEANING AND INSPECTION	
Case	17-09-139
Converter and Oil Cooler	17-09-140
Forward, Direct, Intermediate, Overdrive, Coast and Reverse Clutches	17-09-139
Oil Cooler Tube Leakage	17-09-140
One-Way Clutches	17-09-139
Output Shaft	17-09-139
Planetary Carriers	17-09-139
Thrust Bearings	17-09-140
Transmission	17-09-138
Transmission Fluid Drain and Refill	17-09-140
Valve Bodies	17-09-139
CONDITION/CAUSE	
Electrical Diagnosis	17-09-30
DESCRIPTION	
E4OD Automatic Transmission	17-09-2
DIAGNOSIS AND TESTING	
General Diagnosis and Testing	17-09-7
DISASSEMBLY AND ASSEMBLY	
Center Support	17-09-116
Coast Clutch Cylinder Assembly	17-09-102
Extension Housing	17-09-135
Forward Carrier	17-09-129
Forward Clutch Assembly	17-09-124
Forward Hub and Ring Gear	17-09-116
Input Shell	17-09-130

SUBJECT	PAGE
DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Intermediate Brake Drum	17-09-118
Intermediate/Overdrive Cylinder Assembly	17-09-112
Overdrive Ring Gear And Center Shaft Assembly	17-09-107
Pump	17-09-97
Reverse Clutch Piston	17-09-134
Reverse One-Way Clutch	17-09-132
Reverse Planet Carrier	17-09-131
Selective Snap Rings:	17-09-122
Specification:	17-09-122
Stack Up Clearance Specification:	17-09-128
Subassemblies	17-09-97
IN VEHICLE SERVICE	
Extension Housing Gasket	17-09-49
Manual Lever Seal	17-09-57
Parking Mechanism	17-09-50
Valve Body and Intermediate Band Servo	17-09-51
REMOVAL AND INSTALLATION	
Transmission	17-09-41
SPECIAL SERVICE TOOLS	17-09-141
SPECIFICATIONS	
Fluid Capacity	17-09-141
Installation of Cooling Lines	17-09-141
Installation of Transmission	17-09-141
VEHICLE APPLICATION	17-09-1

VEHICLE APPLICATION

Applies to E-250 - E-350 Over 8500 lb GVW Except 4.9L, F-250 - F-350 over 8500 lb GVW Except 4.9L, and F-Super Duty Series Vehicles.

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DESCRIPTION

E4OD Automatic Transmission

The E4OD Transmission is a fully automatic, electronically controlled, four-speed unit with a three element locking torque converter. The main operating components of the E4OD transmission include a converter clutch, six multiple-disc friction clutches, one band, two sprag one-way clutches and a roller one-way clutch which provide for the desired function of three planetary gear sets.

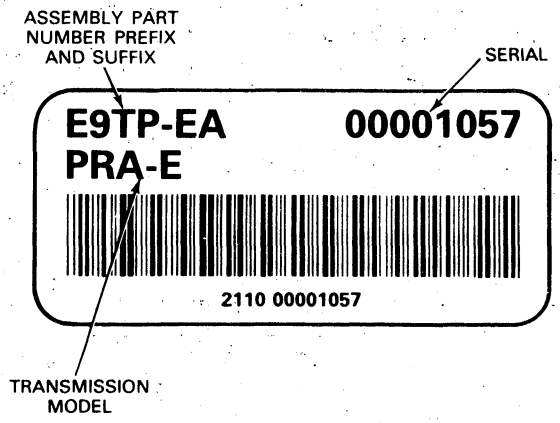
Transmission gear selection in the Ⓓ range and converter clutch operation is controlled by the EEC-IV control system. Operating conditions are relayed to EEC-IV by various sensors throughout the vehicle. The EEC-IV compares these conditions with electronically stored parameters and logically determines the state that the transmission should operate at.

In the Ⓓ range, automatic operation of all four gears is possible. The Overdrive Cancel Switch, located on the vehicle's dashboard, disables overdrive operation and enables automatic operation through the first three gears.

Manual gear selection is available in the 1 and 2 range. Second gear is commanded when the gear selector is in the 2 range and when downshifted into the 1 range at speeds above approximately 56 Km/h (35 mph) (for diesel 48 Km/h (30 mph). First gear is commanded in the 1 range at startups and when downshifted into 1 range below approximately 56 Km/h (35 mph) (for diesel 48 Km/h (30 mph).

NOTE: Any reference to Intermediate Brake Drum and Direct Clutch Cylinder are one and the same.

Transmission Identification Tag



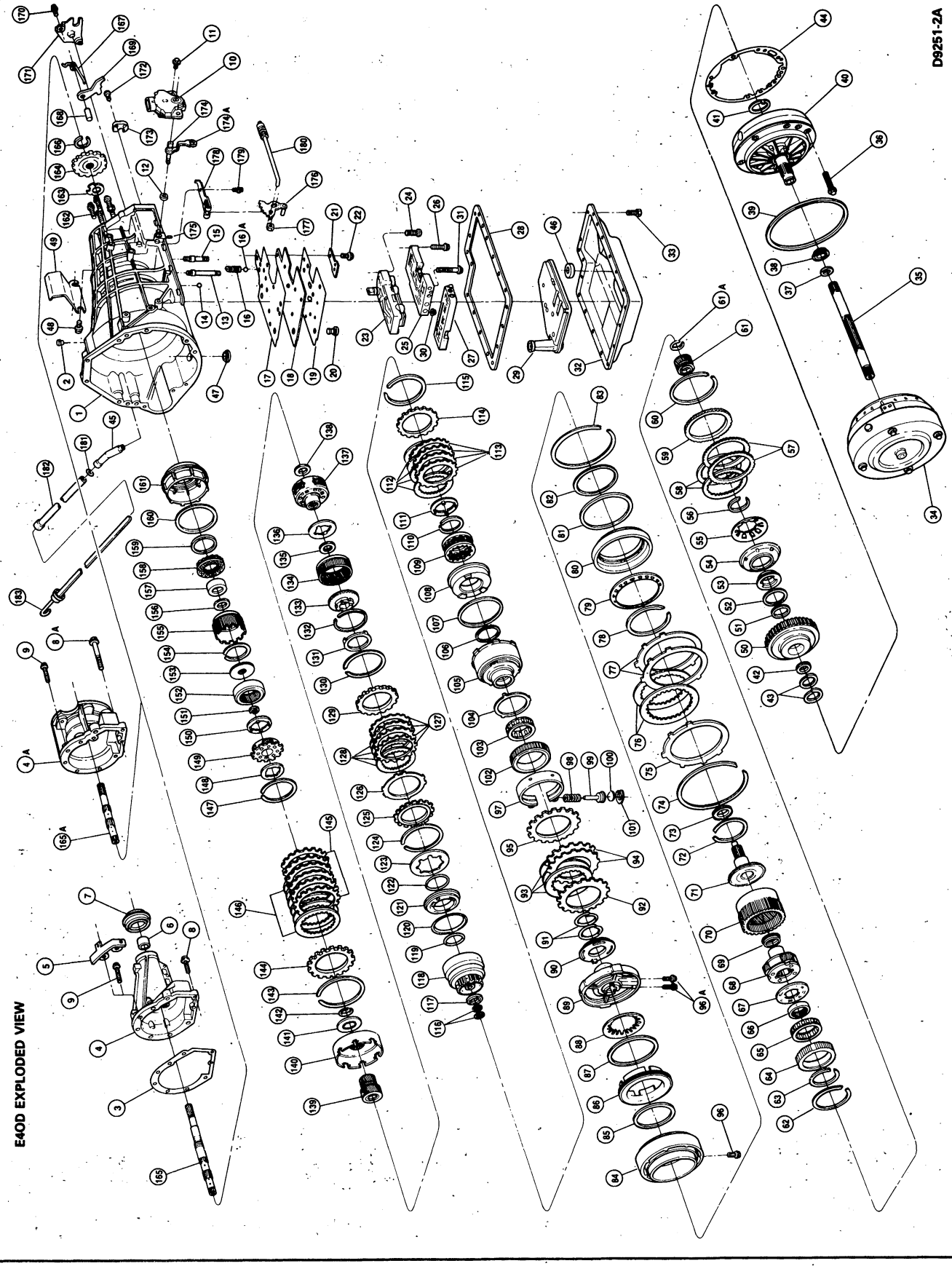
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Located on the LH side to the rear of the manual level position sensor.

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DESCRIPTION (Continued)

E4OD Automatic Transmission



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E4OD EXPLODED VIEW LEGEND

1.	7005	CASE ASSEMBLY
2.	7034	VENT ASSEMBLY
3.	7086	GASKET — EXTENSION HOUSING
4.	7A039-CB	EXTENSION ASSEMBLY (4X2)
#	7A041	— EXTENSION & BUSHING ASSY.
#	7A040	— EXTENSION
4A.	7A039-DA	EXTENSION ASSEMBLY (4X4)
	7A039-EA	EXTENSION ASSEMBLY (SUPERDUTY)
#5.	7H102	BRACKET — WIRING
6.	7A034	BUSHING — EXTENSION HOUSING (4X2)
7.	7052	SEAL — EXTENSION HOUSING (4X2)
8.	N605802-S36	BOLT — EXTENSION (4X2 BOTTOM) (2 PCS.) M10X1.5X35MM
8A.	N606569-S36	BOLT — EXTENSION (SUPERDUTY & 4X4 BOTTOM) (2 PCS.) M10X1.5X90MM
9.	N605803-S36	BOLT — EXTENSION (TOP) (7 PCS.) M10X1.5X40MM
10.	7F293	SENSOR — MANUAL LEVER POSITION
11.	N805312-S100	BOLT ASSEMBLY (2 PCS.) M6X1.0X30MM
12.	7B498	SEAL — MANUAL LEVER
13.	N805331-S	STUD — CASE TO SOLENOID BODY (1 PC.) M6X1.0X79MM
14.	7E195	BALL — RUBBER CHECK (10 PCS.) (2 IN MAIN CONTROL)
	379581-S	BALL — STEEL CHECK (1 PC.)
15.	N805330-S	STUD — CASE TO CONTROL ASSEMBLY (4 PCS.) M6X1.0X61.25MM
16.	7D017	EPC BLOW-OFF SPRING
16A.	353078-S	EPC BLOW-OFF BALL
17.	7D100	GASKET — SEPARATOR
#18.	7A008	PLATE — SEPARATOR
19.	7C155	GASKET — SEPARATOR
20.	7G308	SCREEN — SOLENOID
#21.	7F282	PLATE — SEPARATOR PLATE REINFORCING
22.	N605772-S	BOLT (3 PCS.) M6X1.0X16MM
23.	7G391	SOLENOID BODY ASSEMBLY
24.	N805329-S	BOLT — TORX HEAD (9 PCS.) M6X1.0X40MM
25.	7A100	MAIN CONTROL BODY ASSEMBLY
26.	N805326-S	BOLT (18 PCS.) M6X1.0X42.5MM
27.	7G422	ACCUMULATOR BODY ASSEMBLY
28.	7A191	GASKET — OIL PAN
29.	7G186-AA	FILTER AND SEAL ASSEMBLY (4X2)
	7G186-BA	FILTER AND SEAL ASSEMBLY (4X4)
30.	N805328-S	NUT (5 PCS.) M6X1.0
31.	N805327-S	BOLT (7 PCS.) M6X1.0X66MM
32.	7A264-FA	PAN — OIL (4X2)
	7A264-GA	PAN — OIL (4X4)
33.	N605902-S36	BOLT — OIL PAN (20 PCS.) M8X1.25X12MM
34.	7902	TORQUE CONVERTER ASSEMBLY
	87650-S2	— PLUG — CONVERTER DRAIN 1/8 IN-27
35.	7017	SHAFT — INPUT
36.	N805260-S	BOLT & WASHER ASSEMBLY — PUMP (9 PCS.) M8X1.25X65MM
	7G379	— WASHER — REPLACEMENT (9 PCS.)
37.	7L323	SEAL RING — TEFLON
38.	7A248	SEAL — CONVERTER HUB
39.	7D441	SEAL — SQUARE CUT O.D. PUMP
40.	7A103	PUMP ASSEMBLY
41.	7D014	WASHER — PUMP THRUST
42.	7E486	NEEDLE BEARING ASSEMBLY
43.	7G402	SEAL RING — TEFLON (2 PCS.)
44.	7A136	GASKET — PUMP
45.	7N463	STUB TUBE
46.	7L027	MAGNET — PAN
47.	7N171	PLUG — CONVERTER ACCESS
48.	N605770-S36	BOLT — HEAT SHIELD (2 PCS.)
49.	7A434	HEAT SHIELD — SOLENOID BODY CONNECTOR
50.	7G387	COAST CLUTCH CYLINDER ASSEMBLY
51.	7A548-JA	SEAL — INNER
52.	7A548-EA	SEAL — OUTER
53.	7G419	PISTON
54.	7N519	RING — PISTON APPLY
55.	7B070-EA	SPRING — PISTON RETURN
56.	N804949-S	RING — RETAINING
57.	7B442-CA	PLATE — COAST CLUTCH EXTERNAL SPLINE
58.	7B164-CA	PLATE — COAST CLUTCH INTERNAL SPLINE
59.	7B437-CA	PLATE — COAST CLUTCH PRESSURE
60.	N804950-S	RING — RETAINING (SELECTIVE FIT)
	N804951-S	RING — RETAINING
	N804952-S	RING — RETAINING
61.	7670	GEAR — OVERDRIVE SUN
61A.	377300-S	RING — RETAINING
62.	377155-S	RING — RETAINING (OUTER RACE TO OVERDRIVE RING GEAR)
63.	377135-S	RING — RETAINING (OVERDRIVE OWC TO OUTER RACE)
*64.	7G389	RACE — OVERDRIVE ONE WAY CLUTCH OUTER
*65.	7G381	CLUTCH ASSEMBLY — OVERDRIVE ONE WAY
*66.	7G388	RACE — OVERDRIVE ONE WAY CLUTCH INNER
67.	7G400	WASHER — THRUST
68.	7E031	CARRIER ASSEMBLY — OVERDRIVE PLANETARY
#	7L676	— CARRIER
#	7D008-CA	— PLANET GEARS (4 PCS.)
#	7A238-CA	— PLANET SHAFTS (4 PCS.)
#	7A242-AA	— THRUST WASHERS (8 PCS.)
#	7D037-BA	— NEEDLE BEARINGS (80 PCS.)
#	380225-S	— RETAINING PINS (4 PCS.)
#	7E486	— NEEDLE BEARING ASSEMBLY
69.	7G128	NEEDLE BEARING ASSEMBLY
70.	7653	GEAR — OVERDRIVE RING
71.	7G382	CENTER SHAFT
72.	7G375	RING — RETAINING (CENTER SHAFT TO OVERDRIVE RING GEAR)
73.	7G178	NEEDLE BEARING ASSEMBLY
74.	7B421	RING — OVERDRIVE RETAINING
75.	7B066-BB	PLATE — OVERDRIVE CLUTCH PRESSURE
76.	7B164-EA	PLATE — OVERDRIVE CLUTCH INTERNAL SPLINE
77.	7B442-DA	PLATE — OVERDRIVE CLUTCH EXTERNAL SPLINE
78.	N804948-S	RING — RETURN SPRING RETAINING
79.	7B070-CA	SPRING — OVERDRIVE RETURN
80.	7G418	PISTON — OVERDRIVE
81.	7A548	SEAL — OVERDRIVE OUTER
82.	7F225	SEAL — OVERDRIVE INNER (SAME AS INTERMEDIATE INNER)
83.	7B421	RING — INT./O.D. CYLINDER RETAINING
84.	7G385	CYLINDER — INTERMEDIATE/OVERDRIVE
85.	7F225	SEAL — INTERMEDIATE INNER
86.	7E005	PISTON — INTERMEDIATE
87.	7F224	SEAL — INTERMEDIATE OUTER
88.	7B070-DB	SPRING — INTERMEDIATE RETURN
89.	7G033	SUPPORT ASSEMBLY — CENTER
90.	7L326	WASHER — THRUST
91.	7D429-A	SEAL — DIRECT CLUTCH CAST IRON (2 PCS.)
92.	7B066-CA	PLATE — INTERMEDIATE CLUTCH APPLY
93.	7F219	PLATE — INTERMEDIATE CLUTCH INTERNAL SPLINE
94.	7B442	PLATE — INTERMEDIATE CLUTCH EXTERNAL SPLINE
95.	7B437	PLATE — INTERMEDIATE CLUTCH PRESSURE
96.	N805310-S101	BOLT — CYLINDER HYDRAULIC FEED (1 PC.) M10X1.5X24MM
96A.	N805311-S101	BOLT — CENTER SUPPORT HYDRAULIC FEED (2 PCS.) M12X1.75X31MM
97.	7D034	BAND ASSEMBLY
98.	7D028	SPRING — SERVO RETURN
99.	7E221	PISTON ASSEMBLY — SERVO

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E4OD EXPLODED VIEW LEGEND (CONTINUED)

100.	7D027	PLATE — SERVO COVER
101.	N660246-S	RING — SERVO RETAINING
*102.	7G380	RACE — INTERMEDIATE ONE WAY CLUTCH OUTER
*103.	7F271	CLUTCH ASSEMBLY — INTERMEDIATE ONE WAY
104.	7G401	WASHER — THRUST (LG. DIA.)
105.	7D044	DRUM ASSY. — INTERMEDIATE BRAKE
106.	7A548-GA	SEAL — INNER
107.	7A548-FA	SEAL — OUTER
108.	7A262	PISTON ASSEMBLY
#	7A258	— PISTON
#	375393-S	— CHECK BALL (7/32 INCH DIA.)
#	7E220	— BALL RETAINER
109.	7G298	SPRING — PISTON RETURN
110.	N804817-S	RING — SPRING RETAINING
111.	7D428	WASHER — THRUST (SMALL DIA.)
112.	7B164-GA	PLATE — DIRECT CLUTCH INTERNAL SPLINE
113.	7B442-FA	PLATE — DIRECT CLUTCH EXTERNAL SPLINE
114.	7B066-BA	PLATE — DIRECT CLUTCH PRESSURE
115.	377126-S	RING — RETAINING (SELECTIVE FIT)
	377127-S	RING — RETAINING
	377128-S	RING — RETAINING
	377437-S	RING — RETAINING
	377444-S	RING — RETAINING
116.	7D019	SEAL RING — TEFLON (2 PCS.)
117.	7F374	NEEDLE BEARING ASSEMBLY
118.	7D424	CYLINDER — FORWARD CLUTCH ASSEMBLY
119.	7E244	SEAL — INNER
120.	7A548	SEAL — OUTER
121.	7A262	PISTON ASSEMBLY
#	7A258	— PISTON
#	375393-S	— CHECK BALL
#	7E220	— BALL RETAINER
122.	7D256	RING — PISTON APPLY
123.	7B070-AA	SPRING — PISTON RETURN
124.	377127-S	RING — RETAINING (FOR RETURN SPRING)
125.	7B066-AA	PLATE — FORWARD CLUTCH PRESSURE
126.	7E457	SPRING — CUSHION
127.	7B442-FA	PLATE — FORWARD CLUTCH EXTERNAL SPLINE
128.	7E311-AA	PLATE — FORWARD CLUTCH INTERNAL SPLINE
129.	7B066-BA	PLATE — FORWARD CLUTCH PRESSURE
130.	377127-S	RING — RETAINING (SELECTIVE FIT)
	377437-S	RING — RETAINING
	377444-S	RING — RETAINING
	386841-S	RING — RETAINING
	386842-S	RING — RETAINING
131.	7D090	WASHER — PLASTIC THRUST
132.	377132-S	RING — RETAINING
133.	7D393	HUB — FORWARD
134.	7D392	GEAR — FORWARD RING
135.	7F078	NEEDLE BEARING ASSEMBLY
136.	7D423	WASHER — THRUST
137.	7A398	CARRIER ASSEMBLY — FORWARD PLANETARY
#	7D055	— CARRIER
#	7D008-AB	— PLANET GEARS (4 PCS.)
#	7A238-AA	— PLANET SHAFTS (4 PCS.)
#	7A242-AA	— THRUST WASHERS (8 PCS.)
#	7D037-CA	— NEEDLE BEARINGS (68 PCS.)
#	380225-S	— RETAINING PINS (4 PCS.)
138.	7F078	NEEDLE BEARING ASSEMBLY
139.	7D063	GEAR — FORWARD/REVERSE SUN ASSEMBLY
140.	7D064	INPUT SHELL
141.	7D066	WASHER — THRUST
142.	377300-S	RING — RETAINING
143.	N805207-S	RING — RETAINING
144.	7D408	PLATE — REVERSE CLUTCH PRESSURE
145.	7B442-EA	PLATE — REVERSE CLUTCH EXTERNAL SPLINE
146.	7E312	PLATE — REVERSE CLUTCH INTERNAL SPLINE
147.	377155-S	RING — RETAINING
148.	7D423	WASHER — THRUST
149.	7D006	CARRIER ASSEMBLY — REVERSE PLANETARY
#	7D007	— CARRIER
#	7D008-BB	— PLANET GEARS (4 PCS.)
#	7A238-BA	— PLANET SHAFTS (4 PCS.)
#	7A242-BA	— THRUST WASHERS (8 PCS.)
#	7D037-CA	— NEEDLE BEARINGS (84 PCS.)
#	380225-S	— RETAINING PINS (4 PCS.)
150.	7D423	WASHER — THRUST
151.	387031-S	RING — RETAINING (FOR OUTPUT SHAFT) (1-1/2 IN DIA.)
152.	7A153	GEAR — REVERSE RING
153.	7D164	HUB — OUTPUT SHAFT
154.	377132-S	RING — RETAINING
155.	E7AP-7E193-AA	REVERSE HUB AND CLUTCH ASSY (4X2)
	E7TP-7E193-AA	REVERSE HUB AND CLUTCH ASSY (4X4)
#	E7AP-7D390-AA	— HUB ASSEMBLY (4X2)
#	E7TP-7D390-AA	— HUB ASSEMBLY (4X4)
#	7E392	— SPRING ASSEMBLY
#	7190	— ROLLER — OVERRUNNING CLUTCH
#	377135-S	— RING — RETAINING (2 PCS.)
#	7E194	— BUSHING — OVERRUNNING CLUTCH
156.	7E413	NEEDLE BEARING ASSEMBLY
157.	7D171	RACE — LOW/REVERSE ONE WAY CLUTCH INNER
158.	7F153	SPRING — PISTON RETURN
159.	7D404	SEAL — INNER
160.	7D403	SEAL — OUTER
161.	7D402	PISTON
162.	7D167	BOLTS (5 PCS.) 5/16 IN-24 (ONE WAY CLUTCH TO CASE)
163.	7B368	WASHER — THRUST
164.	7A233	PARKING GEAR
165.	7060-AA	OUTPUT SHAFT ASSEMBLY (4X2)
165A.	7060-CA	OUTPUT SHAFT ASSEMBLY (4X4)
166.	387035-S	RING — RETAINING (1-9/16 IN DIA.)
167.	7D070	SPRING — PARKING PAWL RETURN
168.	387640-S	PIN — PARKING PAWL
169.	7A441	PARKING PAWL
170.	N805232-S	BOLT AND WASHER ASSEMBLY (2 PCS.)
171.	7D419	PLATE — PARKING ROD GUIDE
172.	N805261-S190	BOLT (1 PC.)
173.	7G101	ABUTMENT — PARKING PAWL ACTUATING
174.	7A256	LEVER ASSEMBLY — MANUAL CONTROL
174A.	7341	INSULATOR
175.	7B210	PIN — MANUAL LEVER RETAINING
176.	7A115	LEVER — INNER DETENT
177.	N800287-S36	NUT — INNER DETENT LEVER M14X1.5 HEX
178.	7E332	SPRING ASSEMBLY — MANUAL VALVE DETENT
179.	N805503-S	BOLT — HEX FLANGE HEAD M6X1.0X16.5MM
180.	7D410	ROD ASSEMBLY — PARKING PAWL ACTUATING
181.	87034-94	O-RING FILLER TUBE
182.	7A228	TUBE ASSY. — OIL FILLER
183.	7A020	INDICATOR ASSY. — OIL LEVEL

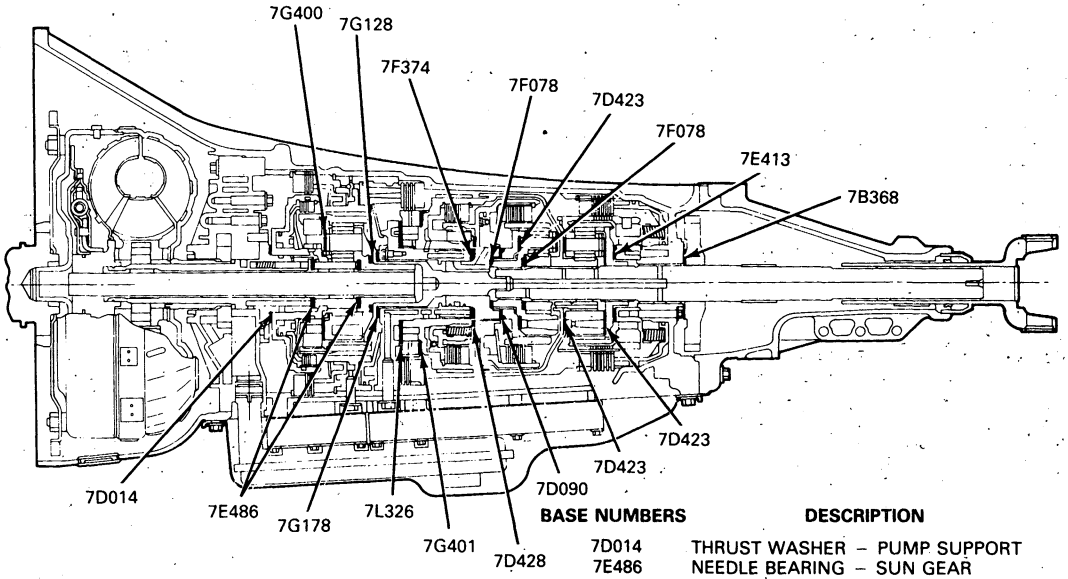
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DESCRIPTION (Continued)

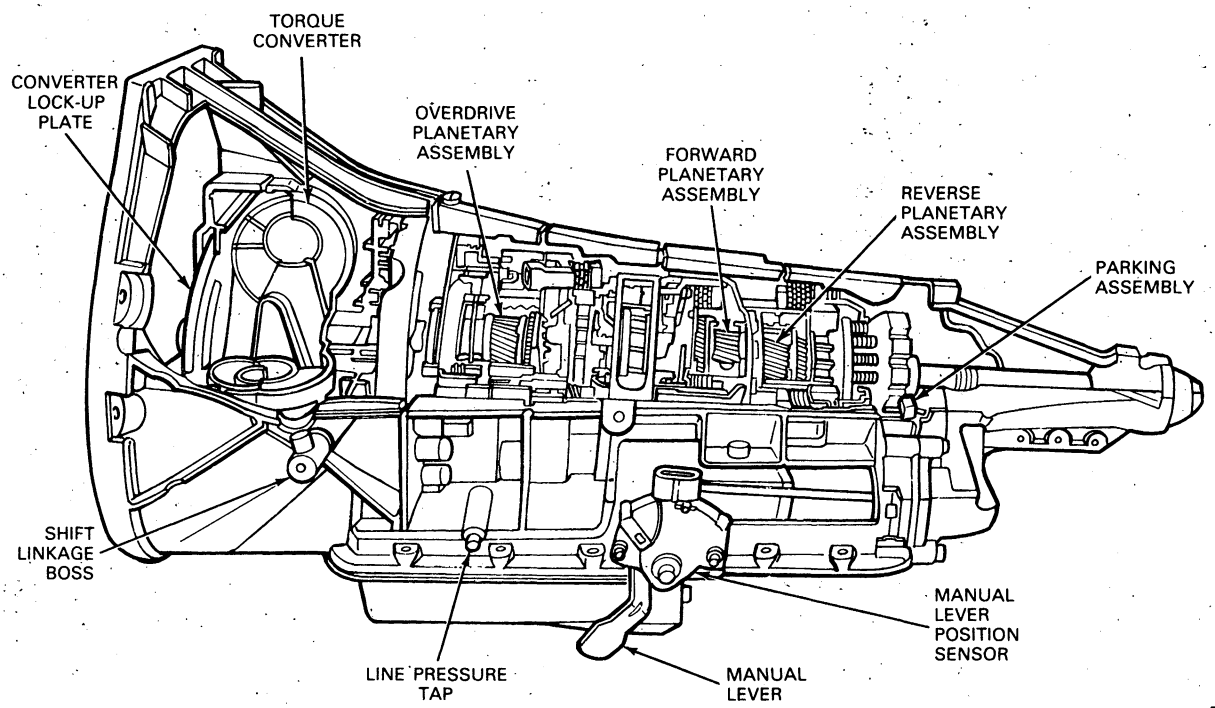
Thrust Washer and Needle Bearing locations



BASE NUMBERS	DESCRIPTION
7D014	THRUST WASHER – PUMP SUPPORT
7E486	NEEDLE BEARING – SUN GEAR
7G400	THRUST WASHER – OVERDRIVE PLANETARY CARRIER
7G128	NEEDLE BEARING – CENTER SHAFT
7G178	NEEDLE BEARING – CENTER SUPPORT
7L326	THRUST WASHER – CENTER SUPPORT
7G401	THRUST WASHER – INTERMEDIATE ONE-WAY CLUTCH
7D428	THRUST WASHER – INTERMEDIATE BRAKE DRUM
7F374	NEEDLE BEARING – FORWARD CLUTCH (PLASTIC) CYLINDER
7F078	NEEDLE BEARING – SUN GEAR
7D090	THRUST WASHER – FORWARD CLUTCH HUB
7D423	THRUST WASHER – PLANETARY CARRIER
7E413	NEEDLE BEARING – OUTPUT SHAFT HUB
7B368	THRUST WASHER – OUTPUT SHAFT

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E4OD AUTOMATIC TRANSMISSION



D9279-2A

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DIAGNOSIS AND TESTING

Diagnosis and testing has been divided into three Sections; General, Condition/Cause Chart, and Electrical. The recommended procedure for diagnosis of any observed condition is spelled out in the Condition Cause Chart.

General Diagnosis and Testing

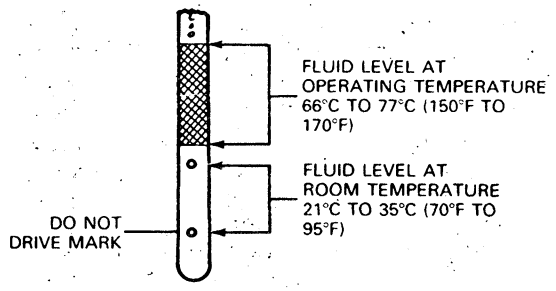
Fluid Level Check

Room Temperature Fluid Level Checking Procedure—Pre-Delivery

The automatic transmission is designed to operate with the fluid level between the ADD and FULL mark on the dipstick at an operating temperature of 65°C - 77°C (150°F - 170°F). Fluid level should be checked under these temperatures. Obtain the operating temperature by driving 24-32 km (15-20 miles) in city traffic.

Operating Temperature—65°C - 77°C (150°F - 170°F)

1. With transmission in PARK, engine at curb idle rpm, foot brake applied and vehicle on level surface, move the transmission selector lever through each range. Allow time in each range to engage transmission, return to PARK, and apply parking brake. **Do not turn off the engine during the fluid level check.**
2. Clean all dirt from the transmission fluid dipstick cap before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push all the way back into the tube. **Be sure it is fully seated.**
4. Pull the dipstick out of the tube again and check fluid level. Fluid level should be between the ADD and FULL mark.



NOTE: The fluid level indication on the dipstick will be different at operating and room temperature. For the correct fluid level reading on the dipstick, follow the appropriate instructions as outlined.

CAUTION: Before adding fluid, be sure that the correct type will be used. Using a fluid other than Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (Ford Part No. E4AZ-19582-B) and Ford Specification ESP-M2C166-H or equivalent, could result in transmission malfunction and/or failure.

If necessary, add enough fluid through the filler tube to raise the level to the correct position. Do not overfill the transmission as this will result in foaming, loss of fluid through the vent, and possible transmission malfunction. Remove excess, if overfilled.

5. Install the dipstick, **making sure it is fully seated in the tube.**

High or Low Fluid Level

A fluid level that is too high will cause the fluid to become aerated. Aerated fluid will cause low control pressure, and the aerated fluid may be forced out the vent.

A fluid that is too low will affect transmission operation. Low level may indicate fluid leaks that could cause transmission damage.

Fluid Condition Check

1. Make the normal fluid level check as outlined.
2. Observe color and odor of the fluid. It should red; not brown or black. Odor may indicate overheating condition, clutch disc or band failure
3. Use an absorbent white facial tissue and wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

   If specks are present in the fluid or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the transmission oil pan, the transmission **must** be disassembled and completely cleaned and serviced. This includes cleaning and flushing the torque converter and transmission cooling system. During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made. After the transmission has been serviced, all diagnostic tests and adjustments listed in the Diagnostic Charts must be completed to ensure that the problem has been corrected.

Fluid Leakage Checks

Check the vehicle speed sensor and speedometer cable connection at the transmission. Replace the rubber seal if necessary.

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DIAGNOSIS AND TESTING (Continued)

Leakage at the transmission oil pan gasket often can be stopped by tightening the attaching bolts to specification. If necessary, replace the gasket.

If leakage is found by the solenoid body connector, refer to In Vehicle Service under Valve Body and Intermediate Band Servo in this Section. Replace O-ring on the connector snout of the solenoid body assembly as outlined.

Check the fluid filler tube connection at the transmission case. If leakage is found here, install a new stub tube.

Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage cannot be stopped by tightening a fluid line tube nut, replace the damaged parts. Refer to Oil Cooler and Steel Lines. When fluid is found to be leaking between the case and the cooler line fitting, tighten the fitting to maximum specification. **Do not try to stop the fluid leak by increasing the torque beyond specification. This may cause damage to the case threads.** If the leak continues, replace the cooler line fitting and tighten to specification. The same procedure should be followed for fluid leaks between the radiator cooler and cooler line fittings.

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying 345-517 kPa (50-75 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure buildup at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, replace the cooler.

If leakage is found at the manual lever shaft, replace the seal.

When a converter drain plug leaks, remove the drain plug. Coat the threads with Pipe Sealant Teflon® D8AZ-19554-A or equivalent and install drain plug. Tighten to specifications.

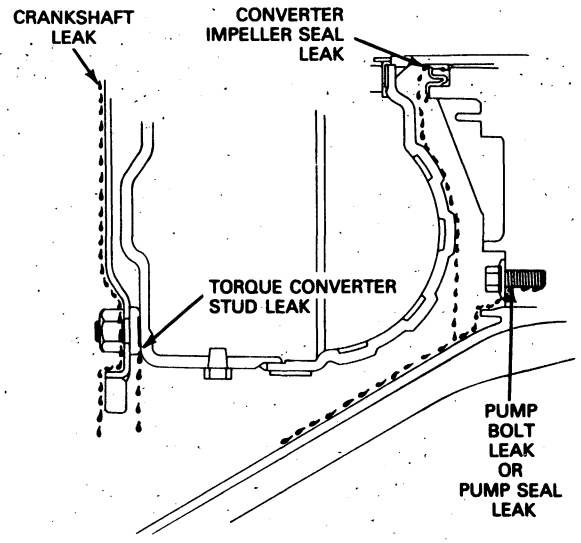
Check for fluid leaking from the end of extension housing. Leakage may result from damaged seal, missing garter spring or worn extension bushing. Replace seal assembly and/or bushing as necessary.

Oil soluble aniline or fluorescent dyes premixed at the rate of 2.5ml (1/2 teaspoon) of dye power to 0.23l (1/2 pint) of transmission fluid have proven helpful in locating the source of fluid leakage. Such dyes may be used to determined whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

Fluid Leakage in Converter Area

In diagnosing and correcting fluid leaks in the converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of the transmission as evidenced by fluid around the converter housing, may have several sources. By careful observation, it is possible in many instances, to pinpoint the source of the leak before removing the transmission from the vehicle. The paths which the fluid can take to reach the bottom of the converter housing are as follows:

Possible Converter Area Leak Points



D9131-1A

1. Fluid leaking by the converter impeller hub seal lip will tend to move along the converter impeller hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.
2. Fluid leakage by the outside diameter of the converter hub seal and the case will follow the same path which the leaks by the inside diameter of the seal follow.
3. Fluid leakage from the converter to the flywheel stud weld will appear at the outer diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel. If a converter-to-flywheel stud leak is suspected, remove converter and pressure check as outlined.
4. Fluid leakage from the pump will flow down the back of the converter housing. Leakage may be from loose or missing pump bolts, torn or damaged pump to case gasket and/or a worn pump bushing.

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DIAGNOSIS AND TESTING (Continued)

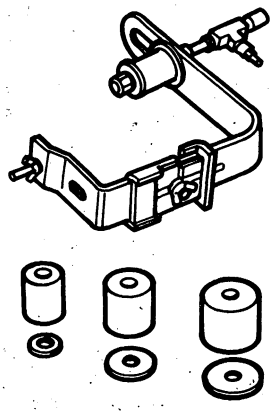
5. Engine oil leaks are sometimes improperly diagnosed as transmission pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the problem.
   a. Leakage at the rocker arm cover may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block causing oil to be present in or at the bottom of the converter housing.
   b. Oil gallery plug leaks will allow oil to flow down the rear face of the block to the converter housing.
   c. Leakage at the crankshaft seal will work back to the flywheel, and then into the converter housing.
6. The following procedures should be used to determine the cause of the leakage before service is made.
   a. Remove the transmission dipstick and note the color of the fluid. Original factory fill fluid is dyed red to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the red color should assist in pinpointing the leak.
   b. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and oil pan. Clean the converter area by washing with suitable nonflammable solvent, and blow dry with compressed air.
   c. Wash out converter housing and the front of the flywheel. The converter housing may be washed out using clean solvent and a squirt-type oil can. Blow all washed areas dry with compressed air.
   d. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist, refer to Pre-Delivery manual Section 50-04, and run the engine at fast idle, then at engine idle, occasionally shifting to the DRIVE and REVERSE ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Converter Leakage Check

If welds on the torque converter indicate leakage, remove the converter and make the following check.

Assemble Rotunda Torque Converter Leak Test Kit 021-00054 or equivalent, to the converter. Test the converter for leaks, following the directions supplied with the kit.

Rotunda Torque Converter Leak Test Kit 021-00054



D9269-1A

Converter and Fluid Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and MUST be removed from the system before the transmission is put back into service.

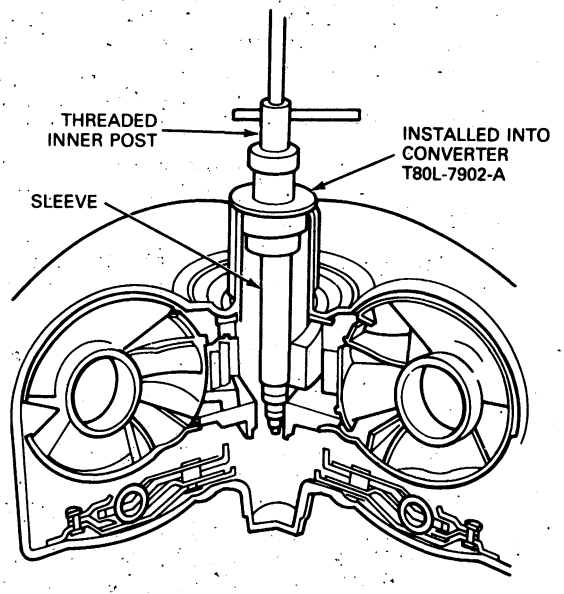
CAUTION: Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter and oil cooler MUST be cleaned by using the Rotunda Torque Converter Cleaner (Model 014-00028) or equivalent. Under NO circumstances should an attempt be made to clean converters by hand agitation with solvent.

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DIAGNOSIS AND TESTING (Continued)

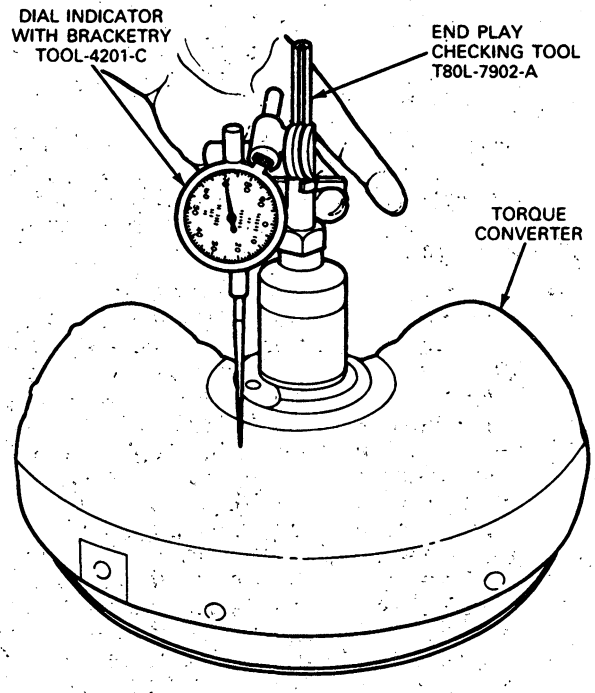
Converter End Play Check

1. Insert Tool T80L-7902-A or equivalent into the converter pump drive hub until it bottoms.
2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked into the spline.



D9273-1A

3. Attach a Dial Indicator with Bracketry TOOL-4201-C or equivalent to the tool. Position the indicator button on the converter pump drive hub, and set the dial face at 0 (zero).



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DIAGNOSIS AND TESTING (Continued)

4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the converter unit if the total end play exceeds the limits. End play specifications are listed below.
5. Loosen the threaded inner post to free the tool, and then remove the tool from the converter.

TORQUE-CONVERTER END-PLAY

Transmission Model	Converter End-Play			
	New or Rebuilt Converter		Used Converter	
	mm	Inch	mm	Inch
E4OD	0.533 Max.	0.021 Max.	1.25 Max.	0.50 Max.

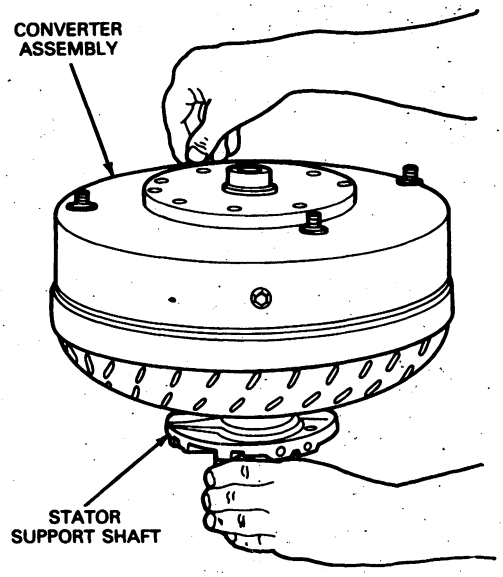
CD9249-2A

Torque Converter One-Way Clutch Inspection

In order to test the converter one-way clutch, insert fingers into the torque converter. Reaching the first splined segment, attempt to spin it. The segment should rotate freely clockwise and should not turn counterclockwise without the converter turning with it. If the segment rotates freely counterclockwise or does not rotate freely clockwise, the one-way clutch has failed and the torque converter should be replaced.

Stator to Impeller Interference Check

1. Position the stator support on a bench with the spline end of the shaft pointing up.



D9270-1A

2. Mount a converter on the stator support with the splines on the one-way clutch inner race engaging the mating splines of the stator support.
3. Hold the stator support stationary and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.
4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.

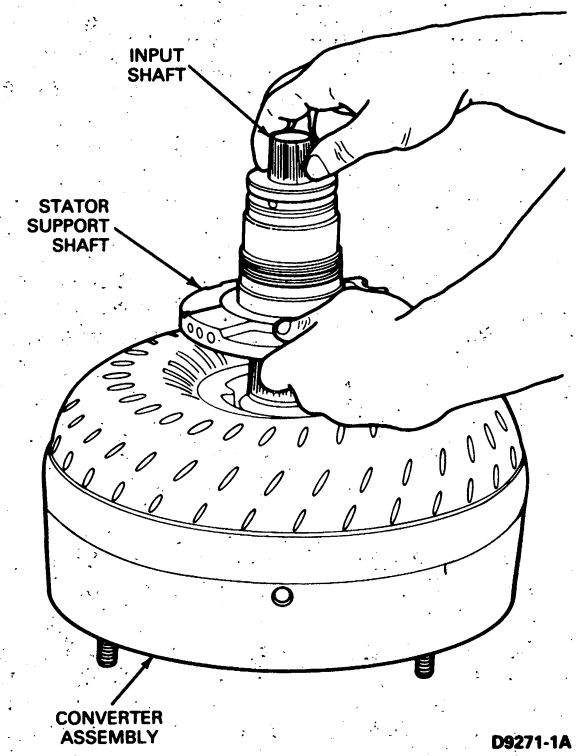
NOTE: Stator support may remain in pump assembly during this test.

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DIAGNOSIS AND TESTING (Continued)

Stator to Turbine Interference Check

1. Position the converter on the bench front side down.
2. Install a stator support to engage the mating splines of the stator support shaft.
3. Install the input shaft, engaging the splines with the turbine hub.



4. Hold the stator shaft stationary and attempt to rotate the turbine with the input shaft. The turbine should rotate freely in both directions without any signs of interference or scraping noise.
5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

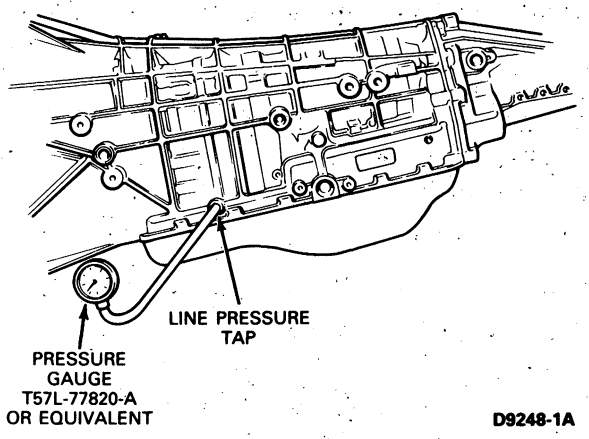
   Check the converter crankshaft pilot for nicks or damaged surfaces that could cause interference when installing the converter into the crankshaft. Check the converter impeller hub for nicks or sharp edges that would damage the pump seal.

NOTE: Stator support may remain in pump assembly during this test.

Line Pressure Test

1. Connect pressure gauge to line pressure tap.

Line Pressure Tap



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DIAGNOSIS AND TESTING (Continued)

2. Start engine and check line pressures. Refer to the following chart to determine if line pressure is within specification.

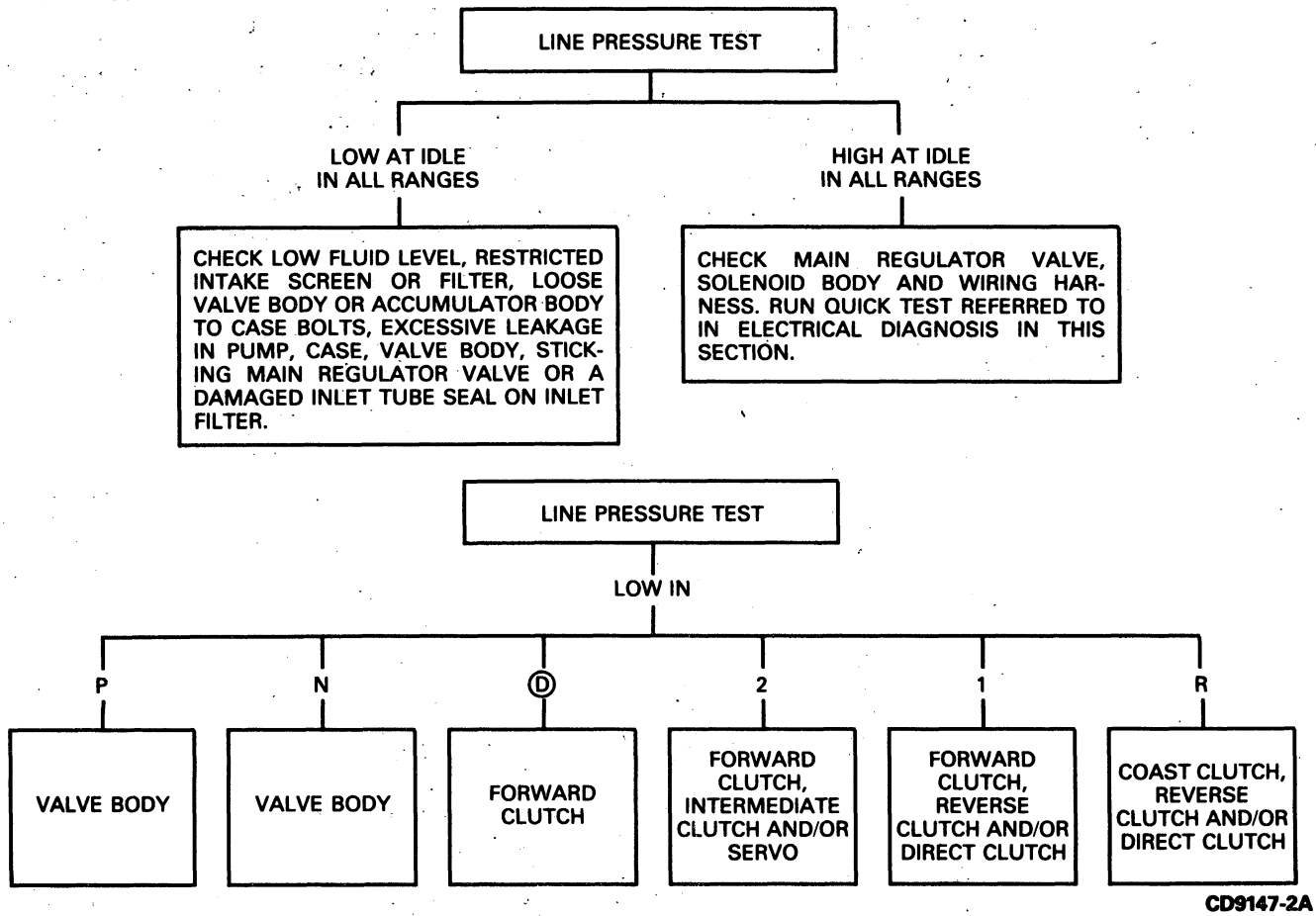
Line Pressure Specifications

Range	Idle		Stall	
	5.8L			
	KPA	PSI	KPA	PSI
P, N	379-448	55-65	—	—
R	586-758	85-110	1655-1827	240-265
Ⓓ, 2	379-448	55-65	1076-1200	156-174
1	510-682	74-99	1082-1255	157-182
	7.3L Diesel			
P, N	379-448	55-65	—	—
R	723-896	105-130	1655-1827	240-265
Ⓓ, 2	379-448	55-65	1076-1200	156-174
1	510-682	74-99	1110-1282	161-186
	7.5L			
P, N	379-448	55-65	—	—
R	621-792	90-115	1655-1827	240-265
Ⓓ, 2	379-448	55-65	1076-1200	156-174
1	510-682	74-99	1082-1255	157-182

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3. If line pressure is not within specification, perform air pressure checks and service main control system.

Line Pressure Test Chart



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DIAGNOSIS AND TESTING (Continued)

Stall Test

The stall test checks the operation of the following items:

- Converter one-way clutch
- Forward clutch
- Low/Reverse one-way clutch
- Reverse clutch
- Overdrive one-way clutch
- Direct clutch
- Coast clutch
- Engine performance

NOTE: The stall test should only be performed with the engine and transmission at normal operating temperatures.

WARNING: APPLY THE SERVICE AND PARKING BRAKES FIRMLY WHILE PERFORMING EACH STALL TEST.

1. Connect tachometer to engine.
2. After testing each of the following ranges Ⓓ, 2, 1 and R, move selector lever to N (NEUTRAL) and run engine for about 15 seconds to allow converter to cool before testing next range.

CAUTION: Do not maintain WOT in any gear range for more than five seconds.

Press accelerator pedal to floor (WOT) in each range. Record rpm reached in each range. Stall speeds should be in appropriate range:

Engine	Stall Speed (rpm)
5.8L	2100-2460
7.3L-D	1650-1910
7.5L	1840-2155

CAUTION: If engine rpm recorded by the tachometer exceeds maximum specified rpm, release accelerator pedal immediately. Clutch or band slippage is indicated.

If the stall speeds were too high, refer to the following Stall Speed Diagnosis Chart. If the stall speeds were too low, first check engine tune-up. If engine is OK, remove torque converter and check torque converter reactor one-way clutch for slippage.

Stall Speed High (Slip)

Range	Possible Source
Ⓓ	• Forward Clutch • Overdrive One-Way Clutch • Low/Reverse One-Way Clutch
R	• Direct Clutch • Overdrive One-Way Clutch • Reverse Clutch
2	• Forward Clutch • Overdrive One-Way Clutch • Intermediate Clutch • Intermediate One-Way Clutch
1	• Forward Clutch • Reverse Clutch and Low/Reverse One-Way Clutch • Coast Clutch and Overdrive One-Way Clutch

CD9148-1A

Transmission Fluid Cooler Flow Test

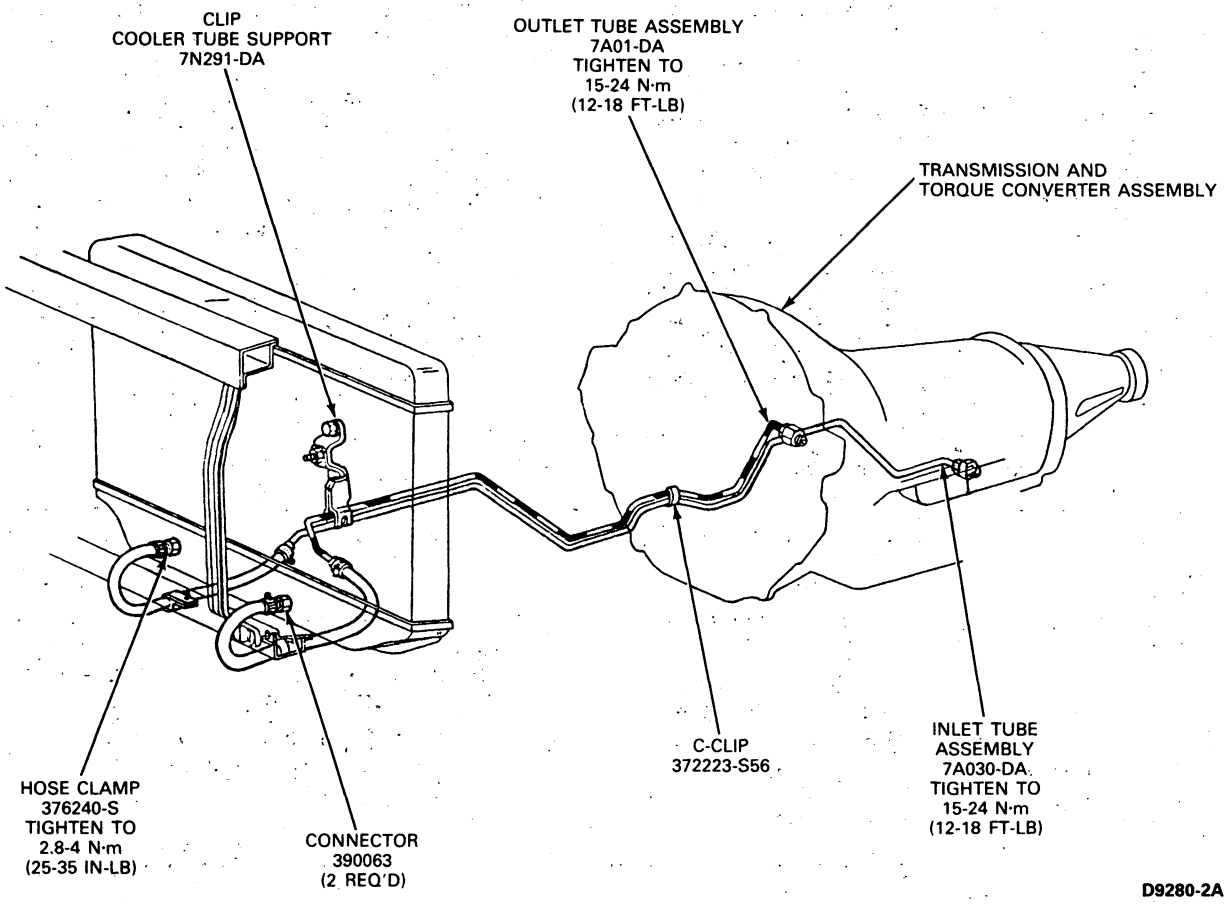
NOTE: The transmission linkage adjustment, fluid level, and line pressure must be within specification before performing this test. Refer to service procedures in this Section.

1. Remove dipstick from filler tube.
2. Place funnel in filler tube.
3. Raise vehicle. Refer to Pre-Delivery manual, Section 50-04.
4. Remove cooler return line (rear fitting) from fitting on transmission case.

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DIAGNOSIS AND TESTING (Continued)

Transmission Cooler Lines



5. Connect a hose to cooler return line. Insert other end of hose into funnel in dipstick tube.
6. Start engine and run at idle with transmission in NEUTRAL range.
7. Observe fluid flow at funnel. When fluid flow is solid, the flow should be liberal, and the test is completed.
8. If the flow is not liberal, stop engine. Disconnect hose from cooler return line and connect it to converter-out line fitting (front fitting) on transmission case.
9. Repeat Steps 6 and 7. If flow is now liberal, refer to appropriate section for diagnosis of transmission fluid cooler. If flow is not liberal, refer to service of pump assembly.

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DIAGNOSIS AND TESTING (Continued)

Shift Point Tests

This test verifies that the shift control system is operating properly.

Road Test

1. Bring engine transmission up to normal operating temperature.
2. Operate the vehicle with the transmission selector in Ⓓ range.
3. Apply minimum throttle pressure and observe the upshift speeds and speeds at which the converter and clutch apply. Refer to Technical Service Bulletin Special Specifications issue.
4. With vehicle in overdrive (fourth gear), depress overdrive cancel switch. Transmission should downshift into third gear.
5. Depress accelerator pedal to the floor (WOT). Transmission should shift from third to second, or third to first depending on vehicle speed and converter clutch should release and then reapply.
6. With vehicle in Ⓓ range above 80 km/h (50 mph) and less than half throttle, move transmission selector from Ⓓ range to 2 range and remove foot from accelerator pedal. Transmission should immediately downshift into second gear. With vehicle remaining in 2 range, move transmission selector into 1 range, and release accelerator pedal. Transmission should downshift into first gear at speeds below 48-56 Km/h (30-35 mph).
7. If transmission fails to upshift and/or downshift as outlined, refer to Diagnostic Charts Section.

In-Shop Test

1. Raise rear of vehicle so that rear wheels are clear of floor.

CAUTION: Do not exceed 97 Km/h (60 mph) indicated speedometer speed. Do not exceed recommended tire speed rating.

2. To check shift valves, place selector lever in Ⓓ range. Apply throttle pressure and observe upshift speeds. At the shift points, the speedometer needle will make a momentary surge, a slight driveline bump may be felt and engine speed will drop without releasing accelerator pedal.
3. If transmission fails to upshift and/or downshift as outlined, refer to Diagnostic Charts in this Section.

Air Pressure Checks

A NO DRIVE condition can exist, even with correct transmission fluid pressure, because of inoperative clutches or bands. An erratic shift can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the selector lever is in a forward gear range (Ⓓ, 2 and 1) a NO DRIVE condition may be caused by an inoperative forward clutch, overdrive one-way clutch or low/reverse one-way clutch.

No manual low (1) coast could be caused by an inoperative coast clutch or reverse clutch.

Failure to drive in R (REVERSE) could be caused by a malfunction of the reverse clutch, overdrive one-way clutch or direct clutch.

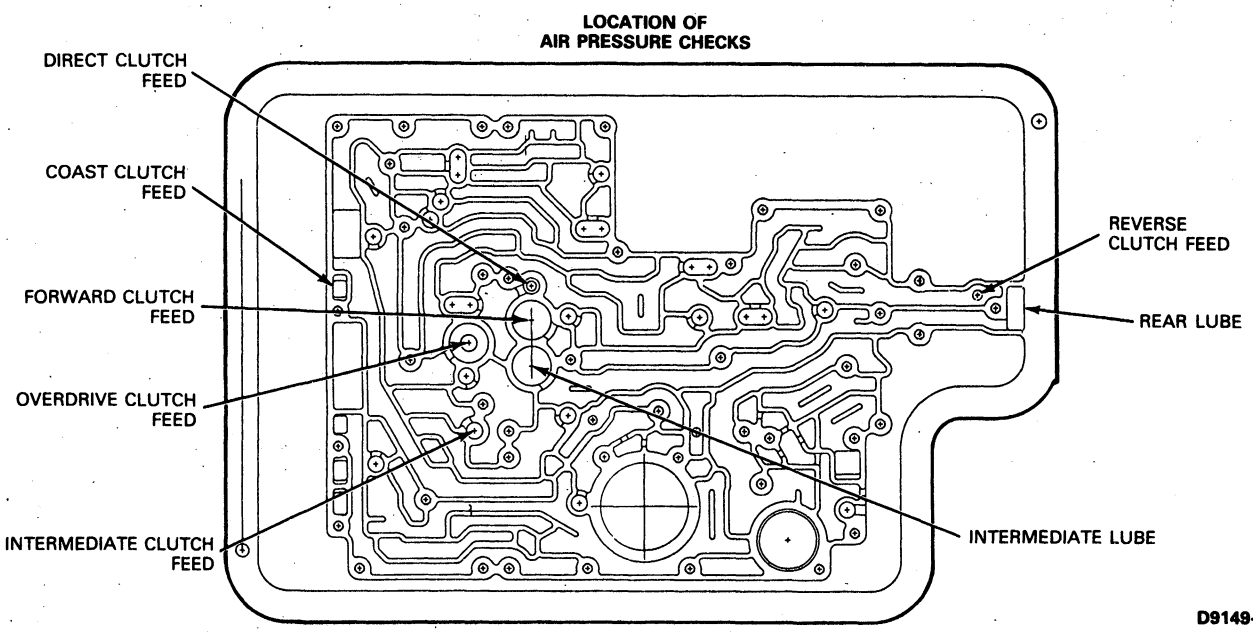
1. Drain transmission fluid and remove oil pan.
2. Remove filter and seal assembly, solenoid body and the main control assemblies.

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DIAGNOSIS AND TESTING (Continued)

3. The inoperative clutches can be located by introducing air pressure into the various test passages as follows:

Air Pressure Check Locations



Clutches: Forward, Coast, Reverse, Overdrive, Direct and Intermediate

Apply air pressure to appropriate clutch test port. A dull thud can be heard, or movement of piston felt when clutch piston is applied. If clutch seal(s) are leaking, a hissing sound will be heard.

Clutch Band Application Chart

Gear	Friction Elements							One-Way Clutch					
								Drive			Coast		
	Coast	Inter-mediate	Direct	Forward	Reverse	Over-Drive	Band	O/D OWC	Inter-mediate OWC	Low Reverse OWC	O/D OWC	Inter-mediate OWC	Low Reverse OWC
	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑧	⑨	⑩
Ⓓ first	*			apply				hold		hold	o/r*		o/r
Ⓓ second	*	apply		apply				hold	hold	o/r	o/r*	o/r	o/r
Ⓓ third	*	apply	apply	apply				hold	o/r	o/r	o/r*	o/r	o/r
Ⓓ fourth		apply	apply	apply		apply		o/r	o/r	o/r	o/r	o/r	o/r
1	apply			apply	apply								
2	apply	apply		apply			apply			o/r			o/r
Reverse	apply		apply		apply				o/r			o/r	

O/D — Overdrive
OWC — One-Way Clutch
O/R — Overrunning
*In D Range with the Overdrive Cancel Switch pressed, the coast clutch is applied and the O/D one-way clutch is bypassed.

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CONDITION/CAUSE

Diagnostic Charts

Refer to the following charts for diagnosis of the transmission mechanical parts.

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD

CONDITION	POSSIBLE SOURCE	ACTION
Fluid Leaks	1. Case breather valve — Transmission fluid foaming	1. Refer to service procedure in Mechanical Diagnostics in this section. Service as required.
	2. Leakage at gasket, seals etc.	2. Refer to General Diagnositics at the beginning of this section.
Fluid venting or foaming	1. Check fluid level (venting) — Transmission overfilled	1. Drain transmission to proper level.
	2. Inspect transmission fluid — Contaminated with anti-freeze or engine overheating	2. Determine source of leak. Service as required.
	3. Inspect transmission fluid filter — Damaged seal — Misassembly to pump	3. Replace filter seals or reassemble fluid filter.
Stalls when stopping	1. Poor engine performance	1. Check engine and service as required.
	2. Check fluid level	2. Drain or fill transmission to proper level.
	3. Check electronic engine control operation	3. Refer to Quick Test Section 14 of the Engine/Emissions Diagnosis Shop Manual, Volume H.
	4. Test converter clutch — Converter clutch does not release	4. Refer to service procedure in this section.
Shift efforts high	1. Inspect manual shift linkage — Damaged or misadjusted	1. Service as required. Refer to Removal and Installation in this section.
	2. Inspect manual lever retainer pin — Damaged	2. Adjust linkage and install new pin.
	3. Check detent spring	3. Service as required.
	4. Inspect inner manual lever nut	4. Tighten nut to specification listed at the end of this section.
Poor vehicle performance	1. Poor engine performance	1. Perform Quick Test Section 14 of the Engine/Emissions Diagnosis Shop Manual, Volume H.
	2. Test converter clutch — Converter clutch does not release	2. Refer to service procedure in this section.
	3. Inspect torque converter one-way clutch — One-way clutch locked up	3. Replace converter.
Vehicle will not start	1. Inspect ignition switch — Misadjusted or defective	1. Adjust or replace as required.
	2. Check fluid level — Fluid level high or low	2. Drain or fill transmission to proper level.
	3. Check electronic engine control operation	3. Refer to Quick Test Section 14 of the Engine/Emissions Diagnosis Shop Manual, Volume H.

CD6481-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
Transmission overheats	1. Excessive tow loads	1. Check owner's manual for tow restriction.
	2. Check fluid level — Fluid level high or low	2. Drain or fill transmission to proper level.
	3. Check electronic engine control operation	3. Refer to Quick Test Section 14 of Volume H of the service manual.
	4. Inspect transmission cooler and cooler lines — Restricted or blocked	4. Service as required. Refer to General Diagnosis in the beginning of this section.
	5. Test converter clutch — Converter clutch does not apply	5. Refer to service procedure in this section.
	6. Inspect valve body — Dirty or sticky valves	6. Clean, service or replace valve body.
	7. Inspect torque converter one-way clutch — One-way clutch locked up	7. Refer to General Diagnosis in the beginning of this section. Replace the converter if necessary.
No 1st gear, starts in higher gear	1. Check line pressure — Low line pressure	1. Perform line pressure test. Refer to service procedure in this section if necessary.
	2. Check solenoid operation	2. Refer to electrical diagnosis procedure in this section. Service as required.
	3. Inspect D2 valve, 2-3 shift valve and 3-4 shift valve — Springs missing or tangled — Dirty or sticky valve	3. Determine source of contamination or damage. Service as required.
No 1-2 upshift	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Check manual linkage — Misadjusted/damaged	2. Service as required. Refer to Adjustments at the beginning of this section.
	3. Test line pressure — Low to intermediate friction clutch	3. Perform line pressure test. Refer to service procedure in this section if necessary.
	4. Check solenoid operation — (S2 solenoid suspected)	4. Refer to electrical diagnosis procedure in this section. Service as required.
	5. Inspect valve body bolts — Bolts loose or tight	5. Tighten bolts to specification.
	6. Inspect valve body — Dirty/sticky valves	6. Determine source of contamination. Service as required.
	7. Inspect 1-2 shift valve — Stuck, nicked or damaged	7. Determine source of contamination. Service as required.
	8. Inspect D2 valve — Spring missing or damaged — Dirty or sticky valve	8. Determine source of contamination. Service as required.

CD6482-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
No 1-2 upshift (Cont'd)	9. Inspect intermediate clutch accumulator regulator valve — Stuck, nicked or damaged	9. Determine source of contamination. Service as required.
	10. Inspect intermediate clutch accumulator — Plunger stuck or damaged — Springs missing or damaged	10. Determine source of contamination. Service as required.
	11. Inspect intermediate clutch assembly — Clutch plates damaged/missing — Piston or seals damaged — Ball check stuck/missing — Feedbolt loose/missing/sealant leak — Clutch hub damaged	11. Determine source of contamination or damage. Service as required.
	12. Inspect intermediate one-way clutch assembly — Damaged cage/sprags — Misassembled on inner race	12. Disassemble and inspect. Service as required.
1-2 Shift harsh or soft	1. Check line pressure — High or low line pressure	1. Perform line pressure test. Refer to service procedure in this section if necessary.
	2. Service line modulator pressure — High or low	2. Refer to service procedure in this section if necessary.
	3. Inspect valve body bolts — Loose or tight	3. Tighten bolts to the specification listed at the back of this section.
	4. Inspect intermediate clutch accumulator regulator valve — Valve stuck, nicked or damaged — Spring missing or tangled	4. Determine source of contamination or damage. Service as required.
	5. Inspect valve body — Dirty or sticky valves	5. Determine source of contamination. Service as required.
	6. Inspect intermediate clutch accumulator — Plunger stuck or damaged — Springs missing or tangled	6. Determine source of contamination or damage. Service as required.
2-3 Shift harsh or soft	1. Check line pressure — High or low line pressure	1. Perform line pressure test. Refer to service procedure in this section if necessary.
	2. Service line modulator pressure — High or low	2. Refer to service procedure in this section if necessary.
	3. Inspect valve body bolts — Loose or tight	3. Tighten bolts to the specification listed at the back of this section.
	4. Inspect intermediate clutch accumulator regulator valve — Valve stuck, nicked or damaged — Spring missing or tangled	4. Determine source of contamination or damage. Service as required.

CD6483-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
2-3 Shift harsh or soft (Cont'd)	5. Inspect intermediate clutch accumulator — Plunger stuck or damaged — Springs missing or tangled	5. Determine source of contamination or damage. Service as required.
	6. Inspect valve body — Dirty or sticky valves	6. Determine source of contamination. Service as required.
	7. Inspect pump air bleed check valve — Valve leaking or damaged	7. Determine source of contamination or damage. Service as required.
	8. Inspect intermediate clutch assembly — Clutch plates damaged/missing — Piston or seals damaged — Ball check stuck or missing — Feedbolt loose/missing sealant leak — Clutch hub damaged	8. Determine source of contamination or damage. Service as required.
No 2-3 upshift	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Check line pressure — Low to direct clutch	2. Perform line pressure test. Refer to service procedure in this section if necessary.
	3. Check solenoid operation — (S1 solenoid suspected)	3. Refer to electrical diagnosis procedure in this section. Service as required.
	4. Inspect valve body bolts — Loose or tight	4. Tighten bolts to the specification listed at the back of this section.
	5. Inspect valve body — Dirty or sticky valves	5. Determine source of contamination. Service as required.
	6. Inspect 2-3 shift valve — Valve stuck, nicked or damaged	6. Determine source of contamination. Service as required.
	7. BS5 check ball missing — Plate seat damaged	7. Service as required.
	8. Inspect direct clutch assembly — Clutch plates damaged/missing — Piston or seals damaged — Ball check assembly stuck or missing	8. Determine source of contamination. Service as required.
	9. Inspect direct clutch cylinder — Seals damaged or missing or holes blocked	9. Determine source of contamination. Service as required.
	10. Inspect center support — Damaged — Feedbolts loose or missing — Center support O.D. or case bore damaged/leaking — Teflon seal damaged	10. Service as required.

CD6484-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
2-3 Shift harsh or soft	1. Check line pressure — High or low line pressure	1. Perform line pressure test. Refer to service procedure in this section if necessary.
	2. Service line modulator pressure — High or low	2. Refer to service procedure in this section if necessary.
	3. Inspect valve body bolts — Bolts tight or loose	3. Tighten bolts to the specification listed at the back of this section
	4. Inspect valve body — Dirty or sticky valves	4. Determine source of contamination. Service as required.
	5. Inspect direct clutch accumulator regulator valve — Valve stuck, nicked or damaged — Spring missing or tangled	5. Determine source of contamination or damage. Service as required.
	6. Inspect direct clutch accumulator — Springs missing or tangled — Plunger nicked or damaged	6. Determine source of contamination. Service as required.
	7. Inspect direct clutch assembly — Clutch plates damaged/missing — Piston or seals damaged — Ball check assembly stuck or missing	7. Determine source of contamination or damage. Service as required.
	8. Inspect direct clutch cylinder — Seals damaged, missing or holes blocked	8. Determine source of contamination. Service as required.
	9. Inspect center support — Damaged — Feedbolts loose or missing — Center support O.D. or case bore damaged/leaking — Teflon seal damaged	9. Service as required.
No 3-4 upshift	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Check line pressure — High or low line pressure	2. Perform line pressure test. Refer to service procedure in this section if necessary.
	3. Check solenoid operation — (S2 solenoid suspected)	3. Refer to electrical diagnosis procedure in this section. Service as required.
	4. Inspect valve body bolts — Bolts tight or loose	4. Tighten bolts to the specification listed at the back of this section.
	5. Inspect valve body — Dirty or sticky valves	5. Determine source of contamination. Service as required.
	6. Inspect 3-4 shift valve — Valve stuck, nicked or damaged — Springs missing or tangled	6. Determine source of contamination. Service as required.
	7. Inspect overdrive accumulator regulator valve — Valve stuck, nicked or damaged — Spring missing or tangled	7. Determine source of contamination or damage. Service as required.

CD6485-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
No 3-4 upshift (Cont'd)	8. Inspect overdrive clutch assembly — Clutch plates burnt or worn — Overdrive clutch cylinder damaged/feedbolt loose or missing/sealant leaking — Cylinder ball check assembly stuck or missing	8. Service as required.
3-4 Shift harsh or soft	1. Check line pressure — Line pressure high or low	1. Perform line pressure test. Refer to service procedure in this section if necessary.
	2. Service line modulator pressure — High or low	2. Refer to service procedure in this section if necessary.
	3. Inspect valve body bolts — Bolts loose or tight	3. Tighten bolts to the specification listed at the back of this section.
	4. Inspect valve body — Dirty or sticky valves	4. Determine source of contamination. Service as required.
	5. Inspect overdrive accumulator regulator valve — Valve stuck, nicked/damaged — Spring missing or tangled	5. Determine source of contamination. Service as required.
	6. Inspect overdrive accumulator — Accumulator plunger stuck or damaged — Springs missing or tangled	6. Determine source of contamination. Service as required.
	7. Inspect overdrive clutch assembly — Clutch plates burnt or worn — Overdrive clutch cylinder damaged or feedbolt loose or missing — Cylinder ball check assembly stuck or missing	7. Service as required.
Shifts 1-3	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Check solenoid operation — (S1 solenoid suspected)	2. Refer to electrical service procedure in this section. Service as required.
	3. Inspect D2 shift valve — Dirty or sticky — Spring missing or damaged	3. Determine source of contamination. Service as required.
	4. Inspect intermediate clutch accumulator regulator valve — Valve sticky or dirty	4. Determine source of contamination. Service as required.
	5. Inspect intermediate friction clutch — Burnt or worn	5. Service as required.

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
Shifts 1-3 (Cont'd)	6. Inspect intermediate one-way clutch assembly — Damaged cage/sprags — Misassembled on inner race	6. Disassemble and inspect. Service as required.
Shift speed high or low	1. Check fluid level — Fluid level high or low 2. Check electronic engine control operation 3. Inspect vehicle speed sensor — Wrong gear/damaged gear	1. Drain or fill transmission to the proper level. 2. Refer to Quick Test Section 14 of the Engine/Emissions Diagnosis Shop Manual, Volume H of the service manual. 3. Repair or replace as necessary.
4-3 Downshift harsh	1. CB7 check ball missing — Plate seat damaged	1. Service as required.
3-2 Downshift harsh	1. CB6 check ball missing — Plate seat damaged	1. Service as required.
2-1 Downshift harsh	1. CB14 check ball missing — Plate seat damaged	1. Service as required.
No drive in drive range	1. Check fluid level — Fluid level low 2. Check line pressure — Line pressure low 3. Inspect manual linkage (internal and external) — Misadjusted, disconnected, damaged, broken or bent 4. Check transmission filter inside oil pan 5. Inspect valve body and pump control body bolts — Loose or tight 6. Inspect pump control body and valve body — Dirty or sticky valves 7. Inspect overdrive one-way clutch — Improperly assembled/damaged — Damaged sprags or races 8. Inspect forward clutch assembly — Burnt or missing clutch plates — Damaged piston or seals — Forward clutch ball check assembly missing or damaged — Center support seals damaged or missing/holes blocked/ feedbolt loose or missing — Forward clutch hub damaged	1. Fill transmission to the proper level. 2. Perform line pressure test. Refer to service procedure in this section if necessary. 3. Service as required. 4. Replace filter if plugged. 5. Tighten bolts to the specification listed at the back of this section. 6. Determine source of contamination. Service as required. 7. Service as required. 8. Determine source of contamination or damage. Service as required.

CD6487-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
No drive in drive range (Cont'd)	9. Inspect reverse one-way clutch — Improperly assembled — Damaged rollers	9. Determine source of damage. Service as required.
	10. Inspect front sun gear/shell — Damaged	10. Determine source of damage. Service as required.
	11. Inspect front and rear carrier — Damaged pinions/lugs to rear ring gear	11. Determine source of damage. Service as required.
	12. Inspect reverse ring gear — Damaged gears/lugs to forward carrier	12. Determine source of damage. Service as required.
	13. Inspect output shaft — Damaged splines	13. Determine source of damage. Service as required.
No reverse	1. Check fluid level — Fluid level low	1. Fill transmission to the proper level.
	2. Inspect manual linkage — Misadjusted, disconnected, damaged, broken or bent	2. Service as required.
	3. Check line pressure — Line pressure low	3. Perform line pressure test. Refer to service procedure in this section if necessary.
	4. Check transmission filter inside oil pan	4. Replace filter if plugged.
	5. Inspect valve body and pump control body bolts — Loose or tight	5. Tighten bolts to the specification listed at the back of this section.
	6. Inspect pump control body and valve body — Dirty or sticky valves	6. Determine source of contamination. Service as required.
	7. Inspect direct clutch accumulator regulator valve — Valve stuck, nicked/damaged — Spring missing or tangled	7. Determine source of contamination or damage. Service as required.
	8. BS5 checkball missing — Plate seat damaged	8. Service as required.
	9. Inspect direct clutch assembly (if 3rd gear inoperative) — Damaged piston or seals — Burnt or missing clutch plates — Direct clutch ball check assembly missing or damaged — Center support seals damaged or missing or holes blocked — Direct clutch hub damaged	9. Disassemble and inspect clutch assembly. Service as required.
	10. Inspect coast clutch assembly for leakage	10. Disassemble and inspect clutch assembly. Service as required.

CD6488-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
No reverse (Cont'd)	11. Inspect reverse clutch — Burnt or missing clutch plates — Damaged piston or seals	11. Determine source of damage. Service as required.
	12. Inspect front and rear carrier — Damaged pinions/lugs to rear ring gear	12. Determine source of damage. Service as required.
No park range	1. Inspect manual shift linkage — Damaged or misadjusted	1. Service as required. Refer to Adjustments at the beginning of this section.
	2. Damage park mechanism — Chipped or broken parking pawl or parking gear — Broken park pawl return spring — Bent or broken actuating rod	2. Determine source of damage. Service as required.
Harsh neutral to drive or neutral to reverse engagements	1. Check fluid level — Fluid level low	1. Fill transmission to the proper level.
	2. Check electronic engine control operation	2. Refer to Quick Test Section 14 of the Engine/Emissions Diagnosis Shop Manual, Volume H.
	3. Worm/damaged/loose U-joint, slip yoke, rear axle or rear suspension	3. Service as required.
	4. Inspect valve body bolts — Loose or tight	4. Tighten bolts to specification.
	5. Engagement control valve — Valve stuck, nicked or damaged	5. Determine source of contamination. Service as required.
	6. CB13 check ball missing — Plate seat damaged	6. Service as required.
	7. Inspect direct clutch accumulator regulator valves — Valve sticking or dirty — Spring missing or tangled	7. Determine source of contamination. Service as required.
	8. Inspect direct clutch accumulator — Accumulator plunger stuck — Accumulator seal damaged or missing — Springs missing or tangled	8. Determine source of contamination. Service as required.
	9. Inspect forward clutch assembly — Burnt or missing clutch plates — Damaged piston or seals — Forward clutch ball check assembly missing or damaged — Center support seals damaged or missing/holes blocked/ feedbolt loose or missing — Forward clutch hub damaged	9. Determine source of contamination or damage. Service as required.
	10. Inspect reverse clutch for leakage.	10. Identify source of leakage. Service as required.
	11. Excessive transmission end play	11. Check transmission end play. Replace selective thrust washer if necessary.

CD9272-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
No forced downshifts	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Check electronic engine control operation	2. Refer to Quick Test Section 14 of Engine/Emissions Diagnosis Shop Manual, Volume H, of the service manual.
	3. Inspect valve body bolts — Bolts loose or tight	3. Tighten bolts to the specification listed in the back of this section.
	4. Inspect valve body — Dirty or sticky valves	4. Determine source of contamination. Service as required.
No engine braking in manual one	1. Check fluid level — Fluid level low	1. Fill transmission to the proper level.
	2. Check line pressure — Line pressure low	2. Perform line pressure test. Refer to service procedure in this section if necessary.
	3. Check solenoid operation — (S1 solenoid suspected)	3. Refer to electrical diagnosis procedure in this section.
	4. Inspect for dirty or sticky valves — Reverse clutch modulator, D2 4-3-2 timing or 2-3 or coast clutch shift valves	4. Determine source of contamination. Service as required.
	5. Check ball missing — BS1, BS3 or CB1 — Plate seat damaged	5. Service as required.
	6. Inspect coast clutch — Worn or burnt — Piston or seals damaged — Stator support damaged or holes blocked — Coast clutch hub damaged or holes blocked	6. Service as required.
	7. Inspect reverse clutch — Worn or burnt — Piston or seals damaged	7. Service as required.
No engine braking in manual second	1. Check fluid level — Fluid level low	1. Fill transmission to the proper level.
	2. Check line pressure — Line pressure low	2. Perform line pressure test. Refer to service procedure in this section if necessary.
	3. Inspect for dirty or sticky valves — 4-3-2 timing, D2, 2-3 or coast clutch shift valve	3. Determine source of contamination. Service as required.
	4. Check ball missing — BS1, BS3 or CB1 — Plate seat damaged	4. Service as required.
	5. Check intermediate servo	5. Perform air pressure test of servo for leakage. Service as required.
	6. Inspect intermediate band or drum — Worn or burnt	6. Service as required.

CD9243-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
No engine braking in manual second (Cont'd)	7. Inspect coast clutch — Worn or burnt — Piston or seals damaged — Stator support damaged or holes blocked — Coast clutch hub damaged or holes blocked	7. Service as required.
Erratic shifts	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Check electronic engine control operation	2. Refer to Quick Test Section 14 of Engine/Emissions Diagnosis Shop Manual, Volume H.
	3. Inspect vehicle speed sensor — Damaged or defective	3 Service as required.
	4. Inspect valve body bolts — Bolts loose or tight	4. Tighten bolts to the specification listed at the back of this section.
	5. Inspect valve body —Dirty or sticky valves	5. Determine source of contamination. Service as required.
Shift hunting	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Check electronic engine control operation	2. Refer to Quick Test Section 14 of Engine/Emissions Diagnosis Shop Manual, Volume H.
High or low line pressure	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Electronic pressure control solenoid malfunction	2. Refer to electrical diagnosis procedure in this section. Service as required.
	3. Main regulator valve or spring — Dirty or sticky valve — Damaged spring	3. Determine source of damage or contamination. Service as required.
	4. Pump assembly — Gears damaged, broken or worn	4. Determine source of damage. Service as required.
No converter clutch apply	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Electrical system or electronic engine control — No lock-up signal — S3 solenoid malfunction — Bulkhead connector damaged — Pinched wires	2. Refer to electrical diagnosis procedure in this section. Service as required.
	3. Inspect stator shaft Teflon seal — Damaged seal	3. Determine source of contamination. Service as required.
	4. Converter clutch control valve — Dirty or sticky	4. Determine source of contamination. Service as required.

CD9244-2A

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CONDITION/CAUSE (Continued)

DIAGNOSIS GUIDE — E4OD (Cont'd)

CONDITION	POSSIBLE SOURCE	ACTION
Converter clutch does not release	1. Check fluid level — Fluid level high or low	1. Drain or fill transmission to the proper level.
	2. Electrical system or electronic engine control — No unlock signal — S3 solenoid malfunction — Bulkhead connector damaged — Pinched wires	2. Refer to electrical diagnosis procedure in this section. Service as required.
	3. Converter clutch control valve — Dirty or stuck valve	3. Determine source of contamination. Service as required.
Line modulator pressure high or low	1. Check line pressure — High or low line pressure	2. Perform line pressure test. Refer to service procedure in this section if necessary.
	2. Inspect line pressure modulator valve — Valve stuck or damaged — Plunger or sleeve stuck or damaged	2. Determine source of contamination or damage. Service as required.

CD9245-2A

Electrical Diagnosis

When referred to this Section, perform the Electronic Engine Control (EEC-IV) Quick Test in Section 14 of the Engine/Emissions Diagnostic Manual Volume H first. This will determine if any service codes for the transmission exist.

The following codes may appear during the EEC-IV Quick Test. Service these codes first and repeat the EEC-IV Quick Test before continuing with the transmission diagnosis.

EEC-IV Quick Test Service Codes

- 26: TOT Out of Self-Test Range: The Transmission Oil Temperature (TOT) sensor registers a temperature not in the allowable range of testing. The test should be repeated with the transmission warmed to the correct testing temperature. (Refer to Engine/ Emissions Diagnosis Shop Manual Volume H for correct temperature.)
- 47: 4x4 Switch Closed: Transmission transfer case is activated into four-wheel drive. Release four-wheel drive and repeat test.
- 65: Overdrive Cancel Switch Not Changing State: Operation of the Overdrive Cancel Switch was not recorded during the Engine On Quick Test. Service this switch as outlined in the Pin Point Tests in Engine/Emissions Diagnosis Manual Volume H.
- 67: MLPS Out of Range/AC On: If AC clutch is on during test, this code will appear. Shut off AC or defrost and repeat test. If the AC unit was off during the test, go to the code in the following Section.

If any of the following service codes appear during the EEC-IV Quick Test perform the Drive Cycle Test for continuous codes as outlined:

Transmission Quick Test Service Codes

- 49: 1-2 Shift Error: Engine speed drop during the 1 to 2 shift does not fall within tolerance limits.
- 56: -40 degree F indicated TOT, Sensor Circuit Open: Voltage drop across the TOT sensor exceeds the scale set for the temperature of -40 degrees F.
- 59: 2-3 Shift Error: Engine speed drop during the 2 to 3 shift does not fall within tolerance limits.
- 62: Converter Clutch Failure: The EEC-IV module picks up excessive amount of converter slip while converter is scheduled to be locked up.
- 66: 315 degrees F indicated TOT, Sensor Circuit Grounded: Voltage drop across the TOT sensor does not reach the scale set for the temperature of 315 degrees F.

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CONDITION/CAUSE (Continued)

- 67: MLPS Out of Range/AC On: Indicated voltage drop across the MLPS (Manual Lever Position Sensor) exceeds the limits established for each position. AC or Defrost on: Fault results from the AC clutch being on during Quick Test.
- 69: 3-4 Shift Error: Engine speed drop during the 3 to 4 shift does not fall within tolerance limit.
- 91: Shift Solenoid 1 Circuit Failure: Solenoid 1 circuit fails to provide voltage drop across solenoid. Circuit open or shorted, or EEC Driver failure.
- 92: Shift Solenoid 2 Circuit Failure: Solenoid 2 circuit fails to provide voltage drop across solenoid. Circuit open or shorted, or EEC Driver failure.
- 93: CCS Solenoid Circuit Failure: Solenoid 4 (Coast Clutch Solenoid) fails to provide voltage drop across solenoid. Circuit open or shorted, or EEC Driver failure.
- 94: CCC Solenoid Circuit Failure: Solenoid 3 (Converter Clutch Control Solenoid) fails to provide voltage drop across solenoid. Circuit open or shorted, or EEC Driver failure.
- 98: Failure Mode and Effects Management Failure/Failed EPC Output Driver: During the Quick Test, the voltage through the EPC (Electronic Pressure Control) solenoid is checked and compared to a voltage through the solenoid after a time delay. An error will be noted if the change tolerance is exceeded.
- 99: EPC Solenoid Circuit Failure/Short: Voltage measured across the Electronic Pressure Control Solenoid is less than a calculated minimum voltage.

Drive Cycle Test

After performing the EEC-IV Quick Test, the following drive cycle test for checking E4OD continuous codes should be performed.

NOTE: Faults have to appear four times consecutively for continuous codes 49, 59 and 69 to be set, and five times consecutively for continuous code 62.

1. Record and zero EEC-IV Quick Test codes.
2. Verify that the transmission fluid level is correct.
3. Warm engine to operating temperature.
4. With transmission in Ⓓ range, press the Overdrive Cancel Switch (LED light should illuminate) and moderately accelerate from stop to 64 Km/h (40 mph). This will allow the transmission to shift into third gear. Hold speed and throttle opening steady for a minimum of 15 seconds (30 seconds above 4000 feet altitude).
5. Press Overdrive Cancel Switch (LED light should turn off) and accelerate from 65 Km/h (40 mph) to 80 Km/h (50 mph). This will allow the transmission to shift into fourth gear. Hold sped and throttle position steady for a minimum of 15 seconds.
6. With transmission in fourth and maintaining steady speed and throttle opening, lightly apply and release brake (to operate stop lamps). Then hold speed and throttle steady for an additional 15 seconds minimum.
7. Brake to a stop and remain stopped for a minimum of 20 seconds with the transmission in Ⓓ range.
8. Repeat Steps 4 through 6 at least five times.
9. Perform EEC-IV Quick-Test and record continuous codes.

If the codes appear, refer to the Pinpoint Test charted below for the appropriate service code.

NOTE: If any other service codes appear, service those codes first as they could affect the electrical operation of the transmission.

NOTE: After the servicing of any error codes resulting from the Quick Test, the Quick Test should be repeated.

Electrical Diagnosis Chart Index

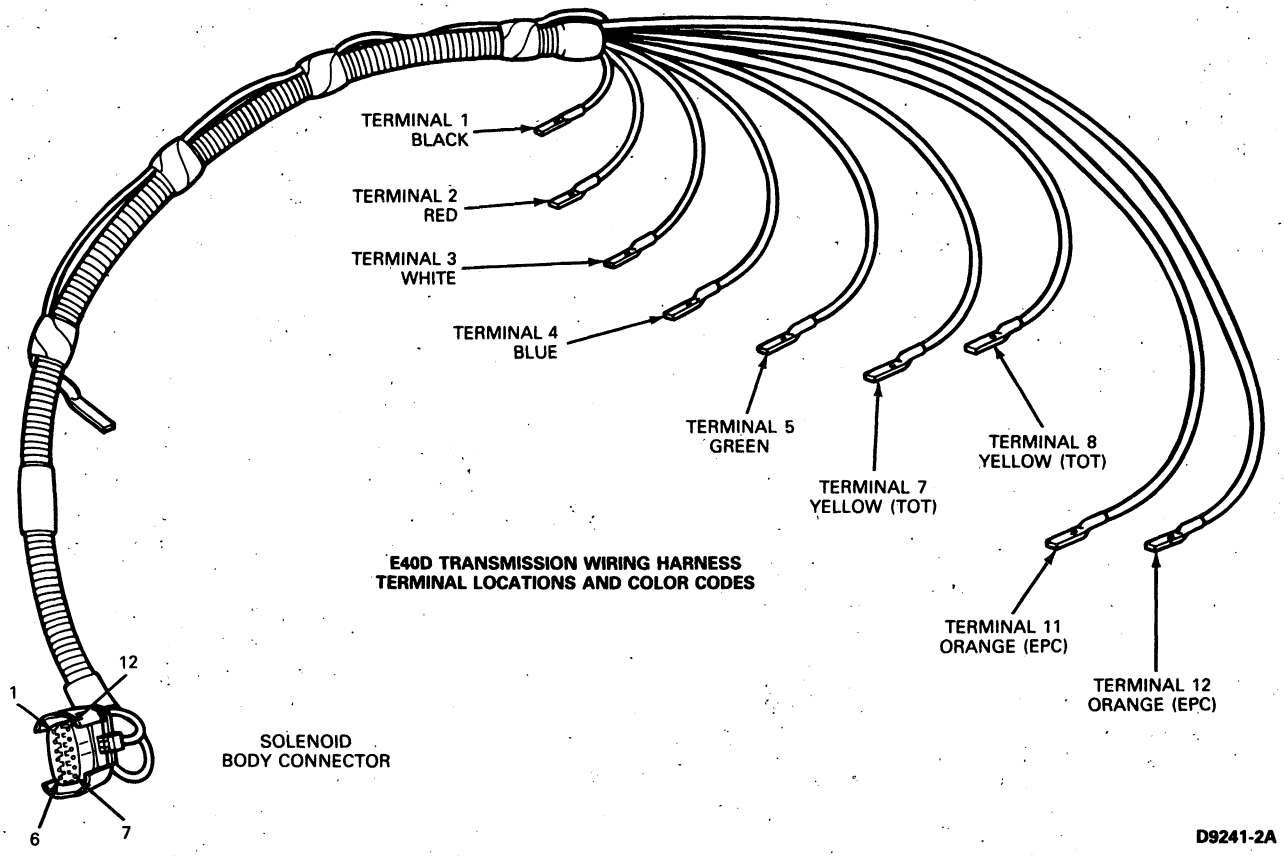
Error Codes	Pinpoint Test
49	AA
56	BB
59	AA
62	CC
66	BB
67	EE
69	AA
91	GG
92	GG
93	GG
94	GG
98	HH
99	HH

CD6489-1A

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CONDITION/CAUSE (Continued)

E4OD Test Harness T89T-70100-A



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CONDITION/CAUSE (Continued)

SERVICE CODES: 49, 59 AND 69 — PINPOINT TESTS AA

TEST STEPS	RESULTS	ACTION TO TAKE
AA1 CHECK HARNESS CONNECTIONS		
• Check that the vehicle harness connector is fully engaged on the transmission bulkhead connector. • Check that the vehicle harness connector terminals are fully engaged in the connector.	(OK) ▶ (OK) ▶	GO to **AA2**. SERVICE or REPLACE as required. REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
AA2 CHECK RESISTANCE OF SOLENOID		
NOTE: Refer to the E4OD Transmission Wiring Harness Terminal Locations and Color Codes preceding these Pinpoint Tests. • Install service jumper harness to the transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Connect ohmmeter negative lead to the black wire on the service harness and the positive lead to the white wire on the service harness. This is to test solenoid 1. • Record the resistance. • Resistance should be between 20-30 ohms. • Connect ohmmeter negative lead to the black wire on the service harness and the positive lead to the red wire on the service harness. This is to test solenoid 2. • Record the resistance. • Resistance should be between 20-30 ohms.	20-30 ohms ▶ High resistance ▶	GO to **AA3**. REPLACE solenoid body and REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
AA3 CHECK SOLENOID FOR SHORT TO GROUND		
• Install service jumper harness to transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Check for continuity between an engine ground and appropriate wire with an ohmmeter or other low current tester (less than 200 milliamps). • Connection should show no continuity (infinite resistance).	Continuity ▶ No continuity ▶	REPLACE Solenoid Body. REPEAT QUICK TEST. GO to **AA4**.

Solenoid	Wire
1	White
2	Red

*Remove solenoid body connector by pushing on the center tab and pulling on the wiring harness.
CAUTION: Do not attempt to pry tab with a screwdriver. Remove heat shield from transmission before removing connector.

CD6490-2A

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CONDITION/CAUSE (Continued)

SERVICE CODES: 49, 59 AND 69 — PINPOINT TESTS AA (Continued)

TEST STEPS		RESULTS	ACTION TO TAKE
AA4	CHECK SOLENOID REGULATOR VALVE		
	• Tear down to solenoid regulator valve. • Inspect solenoid regulator valve for damage or contamination. • Check for stuck or missing spring.	(OK) ▶	CLEAR errors and REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H and the continuous drive test. If codes continue, REFER to appropriate section in Mechanical Diagnosis in this section.
		(OK) ▶	Service as required.

*Remove solenoid body connector by pushing on the center tab and pulling on the wiring harness.
CAUTION: Do not attempt to pry tab with a screwdriver. Remove heat shield from transmission before removing connector.

CD7888-2A

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CONDITION/CAUSE (Continued)

SERVICE CODES: 56 AND 66 — PINPOINT TESTS BB

TEST STEPS	RESULTS	ACTION TO TAKE
BB1 CHECK HARNESS CONNECTIONS		
• Check that the vehicle harness connector is fully engaged on the transmission bulkhead connector. • Check that the vehicle harness connector terminals are fully engaged in the connector.	(OK) ▶ (OK) ▶	GO to **BB2**. SERVICE or REPLACE as required. REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
BB2 CHECK TOT SENSOR RESISTANCE		
NOTE: Refer to the E4OD Transmission Wiring Harness Terminal locations and Color Codes preceding these Pinpoint Tests. • Install service jumper harness to the transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Carefully touch the transmission oil pan on the driver's side, away from the exhaust system, to approximate the temperature. After running the Quick Test, the transmission oil pan should be warm to the touch. (As a guide, warm to the touch is about 41-70 degrees C [105-158 degrees F]). • Connect ohmmeter negative lead and the positive lead to the yellow wires on the service harness. • Record the resistance. • Resistance should be approximately in the following ranges.	Resistance in range ▶ Resistance greater than 100K ▶ Resistance out of range ▶	GO to **BB3**. REPLACE solenoid body and REPEAT QUICK TEST in the Engine/Emissions Shop Manual, Diagnosis Volume H. PERFORM SECOND TEST listed in this step. REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.

TRANSMISSION FLUID TEMPERATURE		
Degrees C	**(Degrees F)**	**Resistance (Ohms)**
0- 20	(32- 58)	37K- 100K
21- 40	(59-104)	16K- 37K
41- 70	(105-158)	5K- 16K
71- 90	(159-194)	2.7K- 5K
91-110	(195-230)	1.5K- 2.7K
111-130	(231-266)	0.8K- 1.5K

• If the resistance was not the appropriate temperature range but was between 0.8K and 100K ohms, perform the following test. If the transmission is cold, run the transmission to heat it up. If the transmission is warm, allow the transmission to cool. Check TOT sensor resistance again. Compare the resistance with the initial resistance. Resistance should decrease if transmission was heated and should increase if transmission was allowed to cool. If the correct change in resistance occurs, REPEAT QUICK TEST.

*Remove solenoid body connector by pushing on the center tab and pulling on the wiring harness.
CAUTION: Do not attempt to pry tab with a screwdriver. Remove heat shield from transmission before removing connector.

CD6491-2A

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CONDITION/CAUSE (Continued)

SERVICE CODES: 56 AND 66 — PINPOINT TESTS BB — Continued

TEST STEPS		RESULTS	ACTION TO TAKE
BB3	CHECK TOT SENSOR FOR SHORT TO GROUND		
	• Install service jumper harness to transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Check for continuity between engine ground and one yellow wire with an ohmmeter or other low current tester (less than 200 milliamps).	Continuity ▶	REPLACE solenoid body and REPEAT QUICK TEST. REPEAT QUICK TEST in the Engine/ Emissions Diagnosis Shop Manual, Volume H.
	• Repeat the continuity check with the other yellow wire. • Connection should show no continuity (infinite resistance).	No continuity ▶	If code was a continuous code, inspect transmission fluid to determine if fluid is burnt. If burnt, teardown transmission and inspect for damage. SERVICE as required and REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.

*Remove solenoid body connector by pushing on the center tab and pulling on the wiring harness.
CAUTION: Do not attempt to pry tab with a screwdriver. Remove heat shield from transmission before removing connector.

CD6492-2A

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CONDITION/CAUSE (Continued)

SERVICE CODE: 62 — PINPOINT TEST CC

TEST STEPS	RESULTS	ACTION TO TAKE
CC1 CHECK HARNESS CONNECTIONS		
• Check that the vehicle harness connector is fully engaged on the transmission bulkhead connector. • Check that the vehicle harness connector terminals are fully engaged in the connector.	(OK) ▶	GO to **CC2**.
	(OK) ▶	SERVICE or REPLACE as required. REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
CC2 CHECK RESISTANCE OF SOLENOID		
NOTE: Refer to the E4OD Transmission Wiring Harness Terminal locations and Color Codes preceding these Pinpoint Tests. • Install service jumper harness to the transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Connect ohmmeter negative lead to the black wire on the service harness and the positive lead to the green wire on the service harness. This is to test converter clutch solenoid. • Record the resistance. • Resistance should be between 20-30 ohms.	20-30 ohms ▶	GO to **CC3**.
	High resistance ▶	REPLACE solenoid body and REPEAT QUICK TEST in the Engine/ Emissions Diagnosis Shop Manual, Volume H.
CC3 CHECK SOLENOID FOR SHORT TO GROUND		
• Install service jumper harness to transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Check for continuity between engine ground and green wire with an ohmmeter or other low current tester (less than 200 millilamps).	No continuity ▶	GO to **CC4**.
	Continuity ▶	Replace Solenoid Body and REPEAT QUICK TEST in the Engine/ Emissions Diagnosis Shop Manual, Volume H.
CC4 CHECK CONVERTER CLUTCH REGULATOR VALVE AND CONVERTER CLUTCH CONTROL VALVE		
• Tear down to converter clutch regulator valve and converter clutch control valve. • Inspect valves for damage or contamination. • Check for struck or missing spring.	(OK) ▶	CLEAR errors and REPEAT continuous drive tests. If errors persist, refer to Mechanical Diagnosis in this section.
	(OK) ▶	SERVICE as required.

*Remove solenoid body connector by pushing on the center tab and pulling on the wiring harness.
CAUTION: Do not attempt to pry tab with a screwdriver. Remove heat shield from transmission before removing connector.

CD6493-2A

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CONDITION/CAUSE (Continued)

SERVICE CODE: 67 — PINPOINT TEST EE

TEST STEPS	RESULTS ▶	ACTION TO TAKE
EE1 ADJUST MANUAL LEVER POSITION SENSOR		
• Apply the parking brake. • Place transmission in Neutral position. • Verify that Manual Lever Position Sensor Tool T89T-20010-J fits in appropriate slots.	(OK) ▶	GO to **EE2**.
	(OK) ▶	ADJUST sensor according to adjustment procedures in this manual and REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
EE2 CHECK OPERATION OF MANUAL LEVER POSITION SENSOR		
• Insert Manual Lever Position Sensor test harness into the Manual Lever Position Sensor connector. • Plug test box into power supply • With transmission in Park, press the buttons on the box. The GOOD light should light only when the P button is pushed. Repeat the test for R, N, Ⓓ, 2 and 1.	(OK) ▶	REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
	(OK) ▶	REPLACE Manual Lever Position Sensor and REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.

CD6498-2A

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CONDITION/CAUSE (Continued)

SERVICE CODES: 91, 92, 93 AND 94 — PINPOINT TEST GG

TEST STEPS	RESULTS	ACTION TO TAKE
GG1 CHECK HARNESS CONNECTIONS		
• Check that the vehicle harness connector is fully engaged on the transmission bulkhead connector. • Check that the vehicle harness connector terminals are fully engaged in the connector.	(OK) ▶ (OK) ▶	GO to **GG2**. SERVICE or REPLACE as required. REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
GG2 CHECK RESISTANCE OF SOLENOID		
NOTE: Refer to the E4OD Transmission Wiring Harness Terminal locations and Color Codes preceding these Pinpoint Tests • Install service jumper harness to the transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Connect ohmmeter negative lead to the black wire on the service harness and the positive lead to the appropriate wire on the service harness. • Record the resistance. • Resistance should be between 20-30 ohms.	20-30 ohms ▶ High resistance ▶	GO to **GG3**. REPLACE solenoid body and REPEAT QUICK TEST in the Engine/ Emissions Diagnosis Shop Manual, Volume H.
GG3 CHECK SOLENOID FOR SHORT TO GROUND		
• Install service jumper harness to transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Check for continuity between engine ground and appropriate wire with an ohmmeter or other low current tester (less than 200 milliamps). • Connection should show no continuity (infinite resistance).	Continuity ▶ No continuity ▶	REPLACE solenoid body and REPEAT QUICK TEST in the Engine/ Emissions Diagnosis Shop Manual, Volume H. REPEAT QUICK TEST in the Engine/Emisssions Diagnosis Shop Manual, Volume H. Problem should not reoccur if the solenoid body passed previous tests.

Error Code	Wire
91	White
92	Red
93	Green
94	Blue

Error Code	Wire
91	White
92	Red
93	Green
94	Blue

*Remove solenoid body connector by pushing on the center tab and pulling on the wiring harness.
CAUTION: Do not attempt to pry tab with a screwdriver. Remove heat shield from transmission before removing connector.

CD9246-2A

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CONDITION/CAUSE (Continued)

SERVICE CODES: 98 AND 99 — PINPOINT TEST HH

TEST STEPS	RESULTS ▶	ACTION TO TAKE
HH1 CHECK HARNESS CONNECTIONS		
• Check that the vehicle harness connector is fully engaged on the transmission bulkhead connector. • Check that the vehicle harness connector terminals are fully engaged in the connector.	(OK) ▶	GO to **HH2**.
	(OK) ▶	SERVICE or REPLACE as required. REPEAT QUICK TEST in the Engine/Emissions Diagnosis Shop Manual, Volume H.
HH2 CHECK RESISTANCE OF SOLENOID		
NOTE: Refer to the E4OD Transmission Wiring Harness Terminal locations and Color Codes preceding these Pinpoint Tests. • Install service jumper harness to the transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Connect ohmmeter negative lead and positive lead to the orange wires on the service harness. • Record the resistance. • Resistance should be between 4.0-6.5 ohms.	4.0-6.5 ohms ▶	GO to **HH3**.
	High resistance ▶	REPLACE solenoid body and REPEAT QUICK TEST in the Engine/ Emissions Diagnosis Shop Manual, Volume H.
HH3 CHECK SOLENOID FOR SHORT TO GROUND		
• Install service jumper harness to transmission bulkhead connector. (Do not pry vehicle harness connector off with a screwdriver.)* • Check for continuity between engine ground and one of the orange wires with an ohmmeter or other low current tester (less than 200 milliamps). • Repeat the continuity check with the other orange wire. • Connection should show no continuity (infinite resistance).	Continuity ▶	REPLACE solenoid body and REPEAT QUICK TEST in the Engine/ Emissions Diagnosis Shop Manual, Volume H.
	No continuity ▶	REPEAT QUICK TEST in the Engine/Emisssions Diagnosis Shop Manual, Volume H. Problem should not reoccur if the solenoid body passed previous tests.

*Remove solenoid body connector by pushing on the center tab and pulling on the wiring harness.
CAUTION: Do not attempt to pry tab with a screwdriver. Remove heat shield from transmission before removing connector.

CD7885-2A

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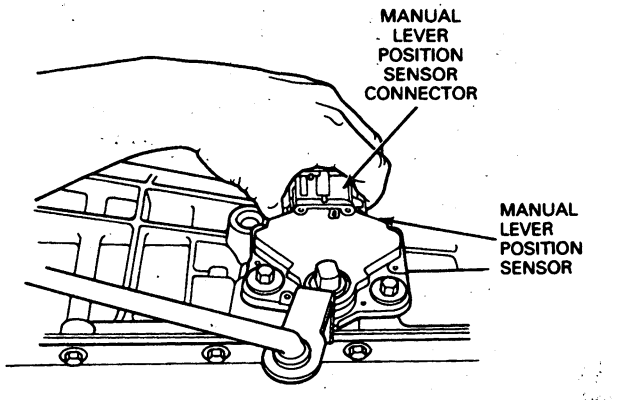
REMOVAL AND INSTALLATION

Transmission

Removal

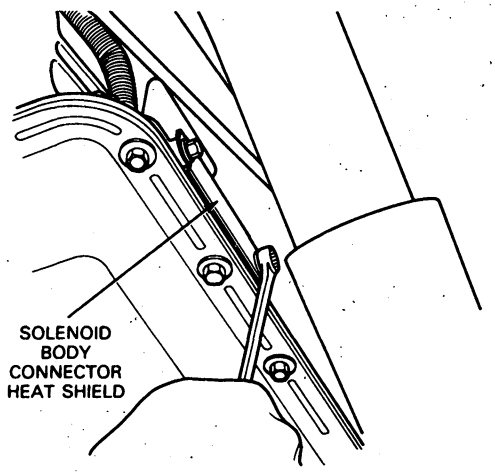
1. Disconnect negative battery cable at the battery.
2. Remove transmission dipstick.
3. Place transmission selector in NEUTRAL position.
4. Raise vehicle on a hoist.
5. On 4x4 models only, remove front driveshaft. Refer to Section 15-67, Front Driveshaft for removal procedures.
6. Remove rear driveshaft. Refer to Section 15-61, Driveshaft—Single Type U-Joint, for removal procedure. On F-Super Duty vehicles, remove the transmission mounted parking brake. Refer to Section 12-70 for procedure.
7. Disconnect shift linkage. Refer to Section 17-02, Shift Control Linkage, for procedure.
8. On 4x4 models only, remove shift linkage from transfer case shift lever. Refer to the appropriate section in Group 16 for transfer case shift linkage removal and installation procedures.
9. Remove manual lever position sensor connector by squeezing connector tabs and pulling on connector.

CAUTION: Do not attempt to pry tab with pry bar or screwdriver. Remove the heat shield from the transmission before attempting to remove the connector.



D9160-1A

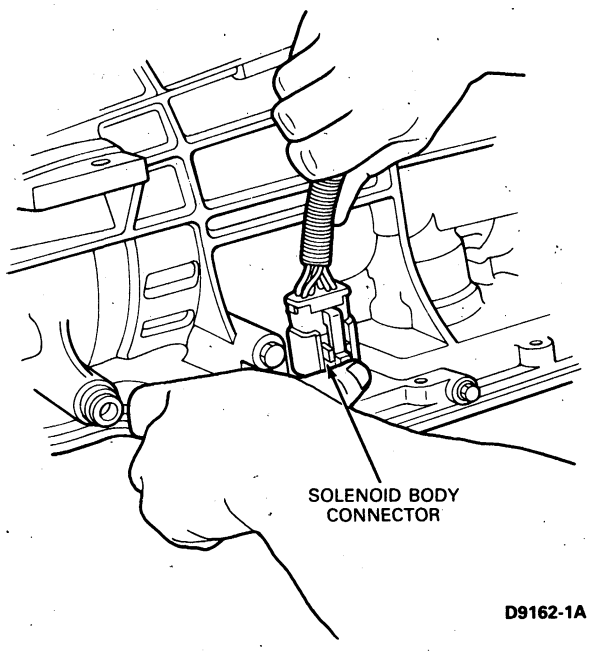
10. To remove solenoid body connector heat shield, loosen two bolts using an 8mm wrench. Remove shield.



D9161-1A

11. Remove solenoid body connector by pushing on the center tab and pulling on the wire harness.

CAUTION: Do not attempt to pry tab with pry bar or screwdriver. Remove the heat shield from the transmission before attempting to remove the connector.

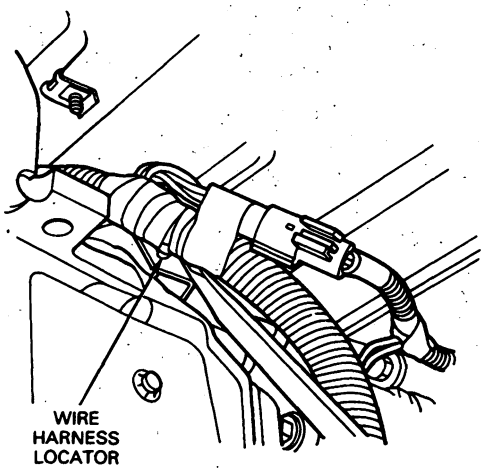


D9162-1A

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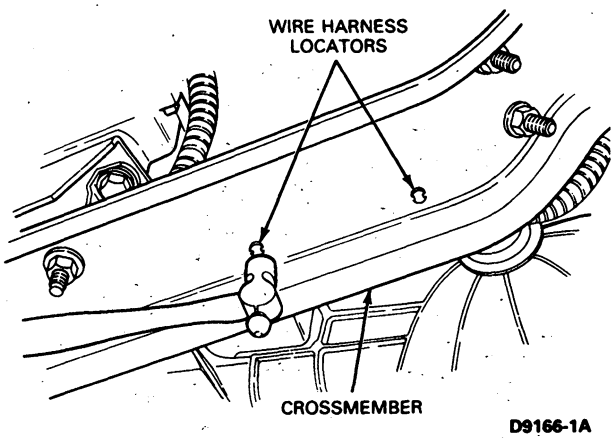
REMOVAL AND INSTALLATION (Continued)

12. On 4x4 models only, remove four-wheel drive switch connector from transfer case. Use care not to overextend tabs.
13. Pry wire harness locator from extension housing wire bracket.



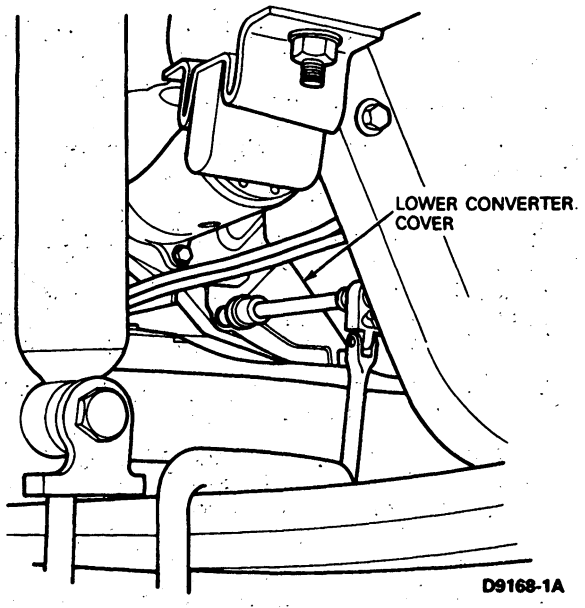
D9165-1A

14. On 4x4 models only, remove wire harness locators from LH side of crossmember.



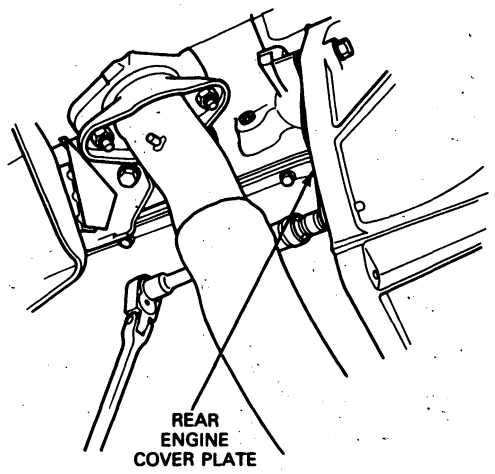
D9166-1A

15. Remove speedometer cable. Refer to Section 33-02, Speedometer, for cable removal and installation procedures.
16. Remove lower converter cover bolts using a 10mm socket.



D9168-1A

17. Remove rear engine cover plate bolts using a 10mm socket.

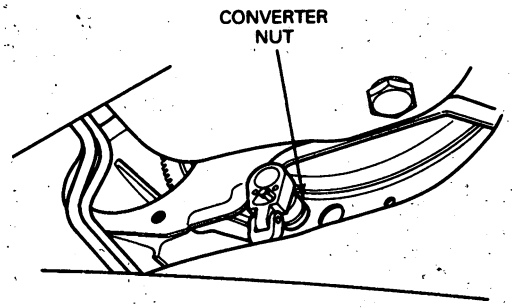


D9169-1A

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REMOVAL AND INSTALLATION (Continued)

18. Remove starter. Refer to Section 28-02, Positive Engagement Starter, in the Light Truck Engine Manual (Volume B) for starter removal and installation procedures.
19. Using a 15/16-inch socket, rotate crankshaft bolt to gain access to converter nuts. Remove four converter mounting nuts, using a 9/16-inch socket and discard.

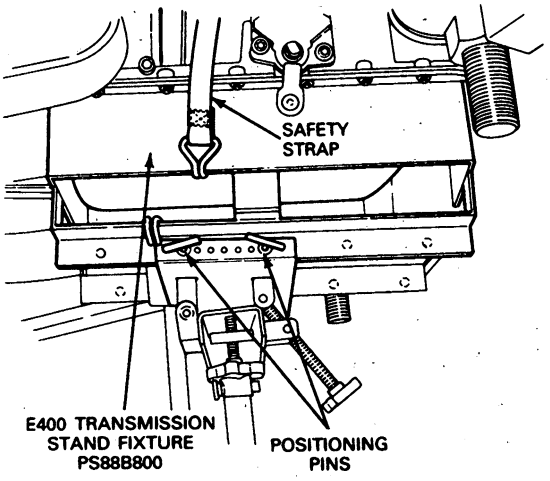


D9172-1A

20. Place E4OD Transmission Stand Fixture, Rotunda Equipment Model 014-00763 or equivalent on universal transmission jack and position fixture as illustrated:

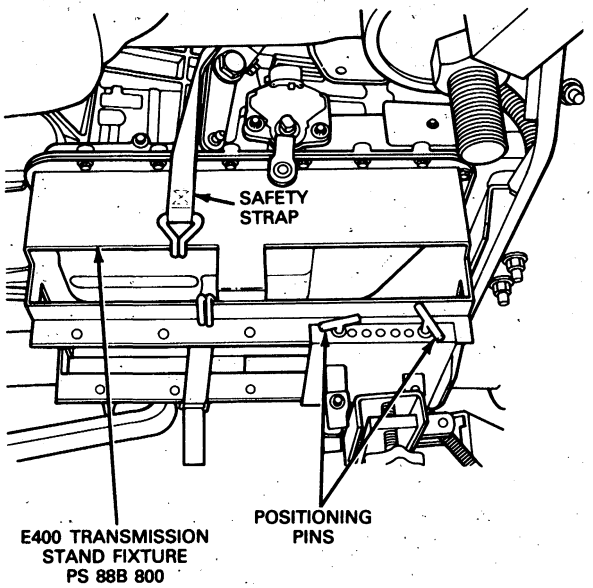
Placement of Positioning Pins

4x2 Vehicles



D9173-1A

4x4 Vehicles

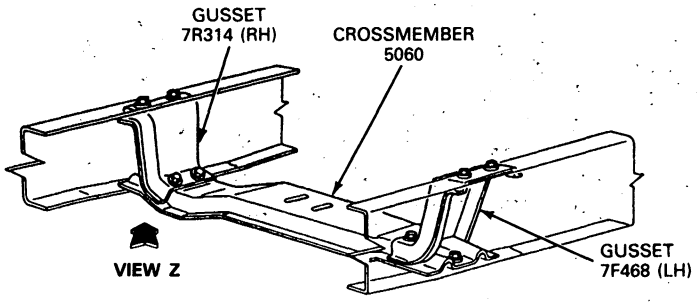


D9174-1A

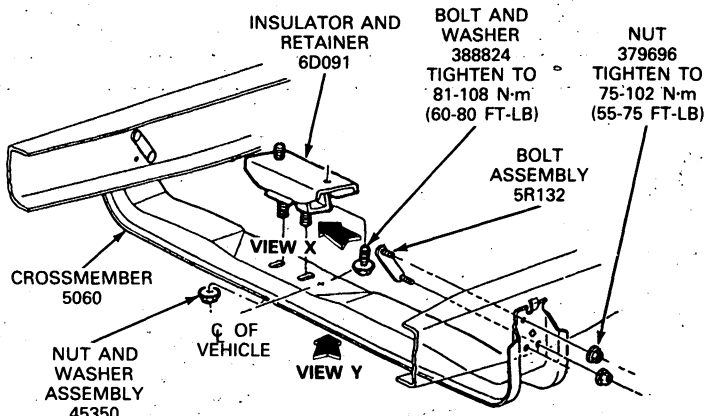
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REMOVAL AND INSTALLATION (Continued)

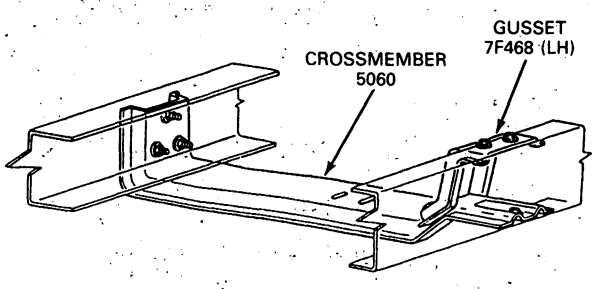
21. Use a safety strap to secure transmission.
22. Loosen the two rear transmission mounting pad nuts using an 18 mm socket. Remove retaining bolts and remove crossmember from transmission.



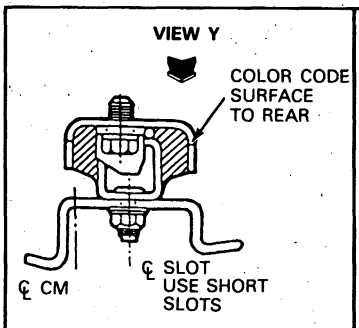
F-250-350 (4x2)



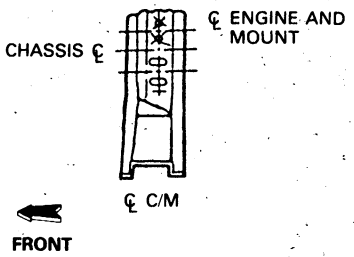
E-250-E-350



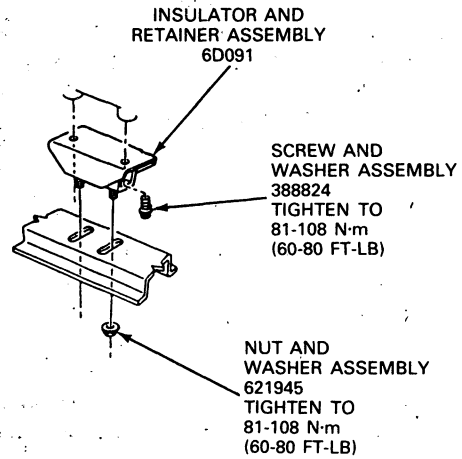
F-250-350 (4x4)
F-SUPERDUTY



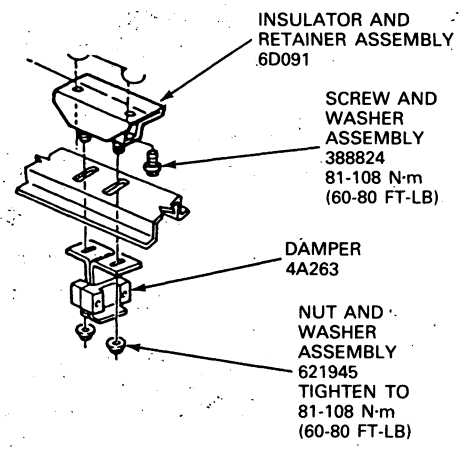
SHOWING INSTALLATION OF REAR ENGINE MOUNT WITH E40D AUTOMATIC TRANSMISSION VIEW X



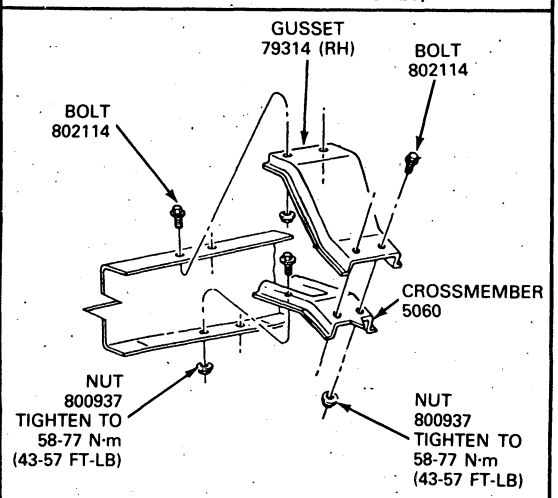
VIEW Y



INSULATOR INSTALLATION



INSULATOR INSTALLATION
(DIESEL 4x4 APPLICATION ONLY)



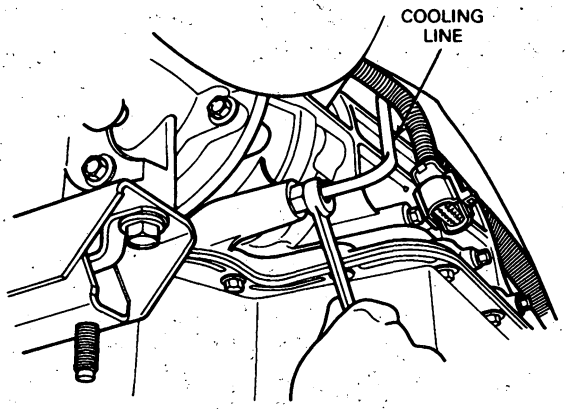
TYPICAL GUSSET INSTALLATION
VIEW Z

D9276-2A

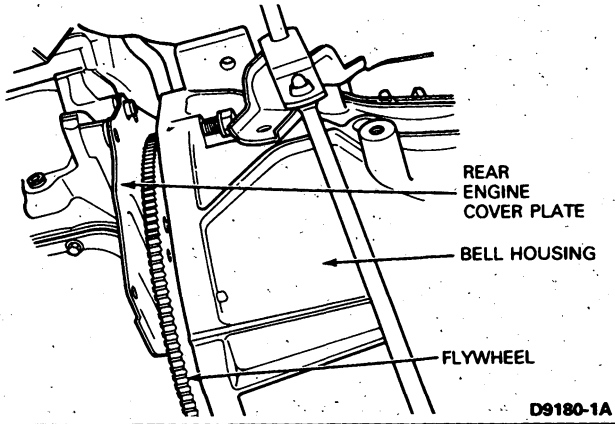
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REMOVAL AND INSTALLATION (Continued)

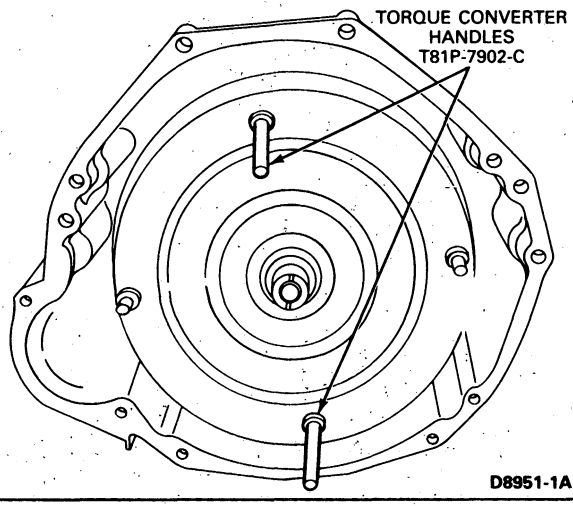
23. Remove transmission cooling lines using a 1/2-inch flare wrench, from transmission case. Cap cooling lines and plug fittings at transmission.



24. Remove six bell housing bolts using a 5/8-inch socket.
25. Back out converter pilot form flywheel and gently lower transmission while observing hardware obstructions.



26. Install Torque Converter Handles, T81P-7902-C or equivalent, on converter with handles in the 6 and 12 o'clock positions.



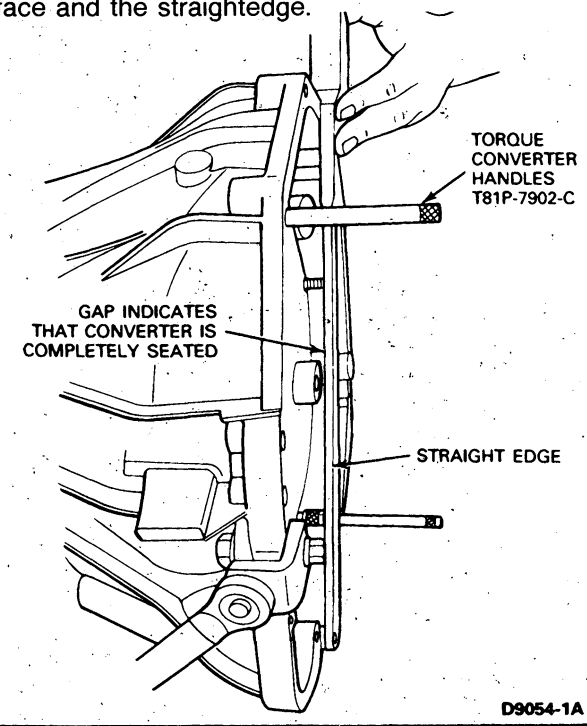
27. Remove transmission filler tube.
28. On 4x4 models only, remove transfer case vent hose form detent bracket. Refer to Section 16-80 or 16-81 for vent hose location.
29. On 4x4 models only, remove the transfer case from the transmission. Refer to Section 16-30 or 16-81 for transfer case removal procedures.
30. On F-Super Duty Models, remove the transmission mounted parking brake. Refer to Section 12-70 for procedure.

Installation

Before installing transmission, check wiring harness for damage. Check connectors for electrical integrity (terminal condition, corrosion and contamination). Repair or replace as required.

1. Place transmission onto E4OD Transmission Stand Fixture Rotunda Equipment Model 014-4-763 or equivalent.
2. On 4x4 models only, install transfer case to transmission. Refer to Section 16-80 or 16-81 for transfer case installation procedures. On F-Super Duty Models, install transmission mounted parking brake. Refer to Section 12-70 for procedure.
3. Install torque converter using Torque Converter Handles T81P-7902-C or equivalent. Carry converter with the handles in the 6 and 12 o'clock positions. Push and rotate the converter onto the pump until it bottoms out.

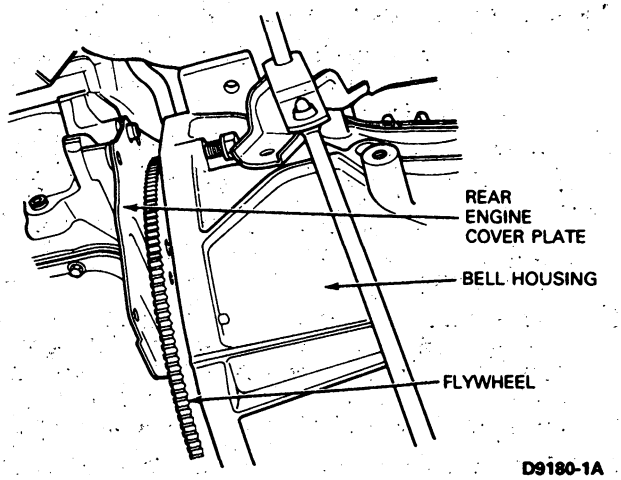
NOTE: Check the seating of the converter by placing a straightedge across the bell housing. There must be a gap between the converter pilot face and the straightedge.



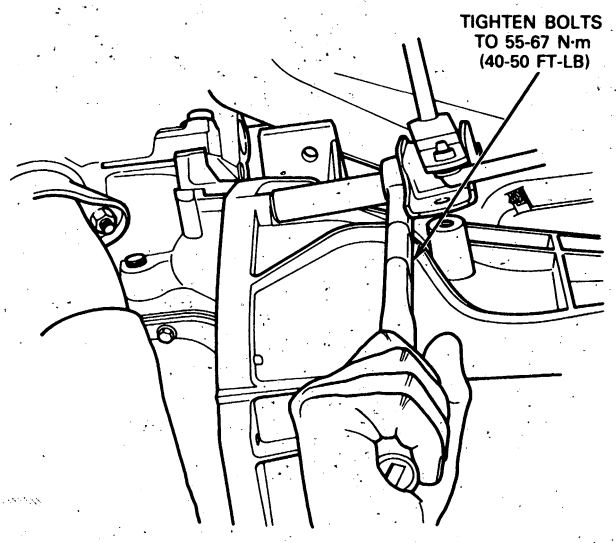
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REMOVAL AND INSTALLATION (Continued)

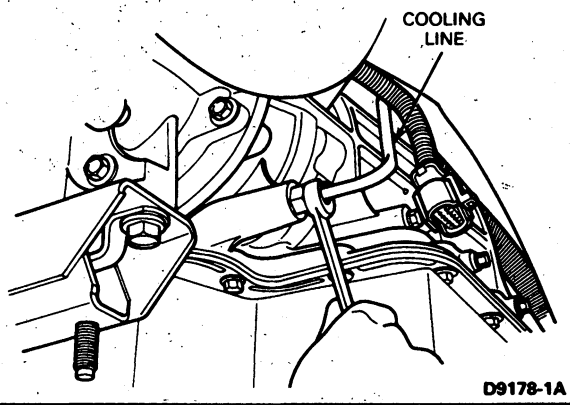
4. Remove converter handles.
5. Check condition of filler tube O-ring, replace if damaged. Install filler tube.
6. Rotate converter studs to align with flywheel mounting holes.
7. Place bolts into bell housing mounting holes.
8. Raise transmission into position while observing all hardware obstructions. Do not allow converter drive flats to disengage from pump gear. Use rubber converter drain plug cover to aid in the alignment of the converter studs. Use care not to damage the flywheel and converter pilot. The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft.



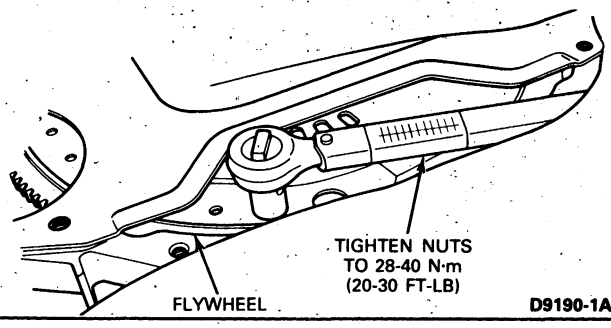
9. Alternately snug-up bell housing bolts using a 5/8-inch socket. Alternately tighten bell housing bolts to 55-67 N·m (40-50 ft-lbs).



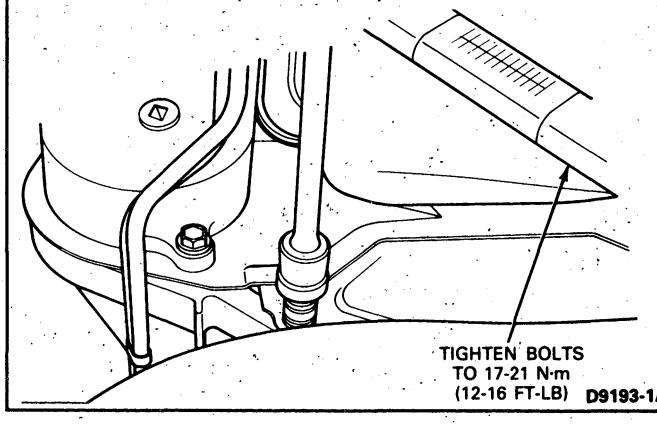
10. Install rubber converter drain plug cover.
11. Install transmission cooling lines to transmission fittings using a 1/2-inch crows foot. Tighten to 24-31 N·m (18-23 ft-lbs).
12. Install crossmember and transmission retaining bolts.



13. Remove safety strap and universal high lift transmission jack.
14. Rotate crankshaft using a 15/16-inch socket on front pulley bolt to gain access to converter studs. Install new stud nuts using a 9/16-inch socket. Tighten to 28-40 N·m (20-30 ft-lbs).

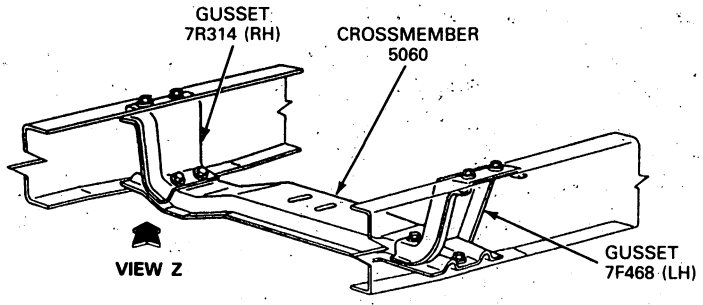


15. Install starter motor. Refer to Section 28-02, Positive Engagement Starter in the Light Truck Engine Manual (Volume B) for starter removal and installation procedures.
16. Install rear engine plate cover and lower dust cover bolts using a 10 mm socket. Tighten to 17-21 N·m (12-16 ft-lbs).

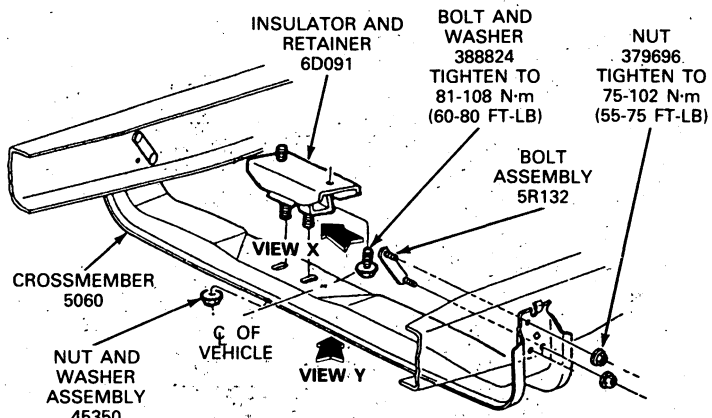


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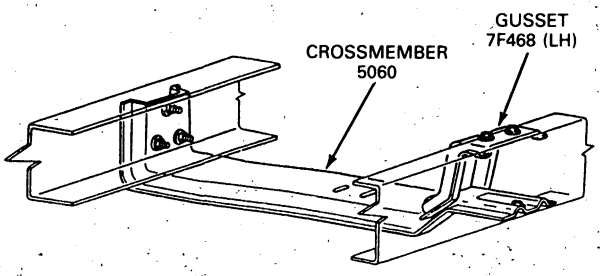
REMOVAL AND INSTALLATION (Continued)



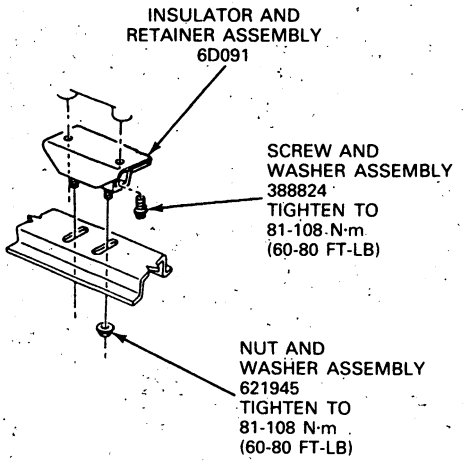
F-250-350 (4x2)



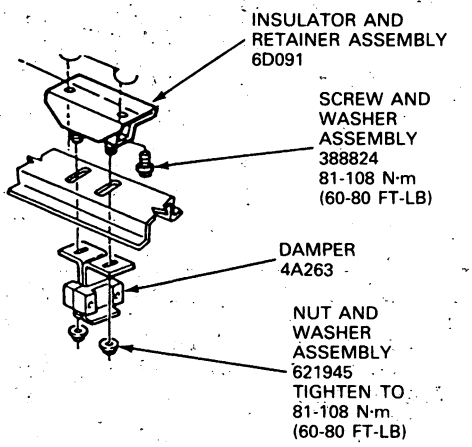
E-250-E-350



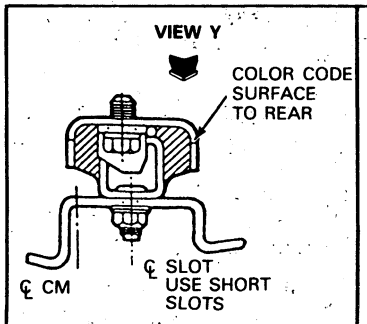
F-250-350 (4x4)
F-SUPERDUTY



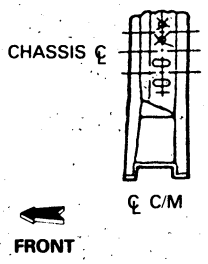
INSULATOR INSTALLATION



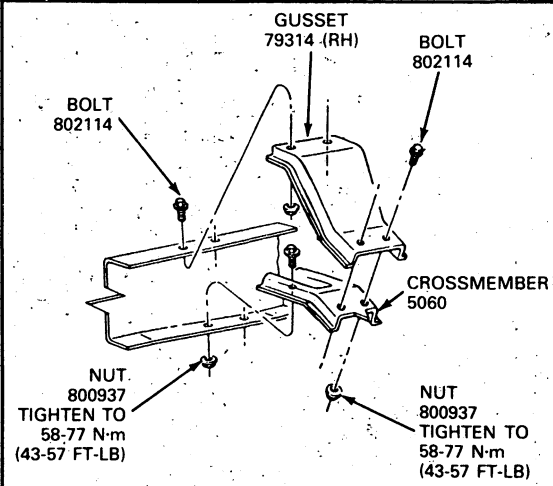
INSULATOR INSTALLATION
(DIESEL 4x4 APPLICATION ONLY)



SHOWING INSTALLATION
OF REAR ENGINE MOUNT WITH
E40D AUTOMATIC TRANSMISSION
VIEW X



VIEW Y



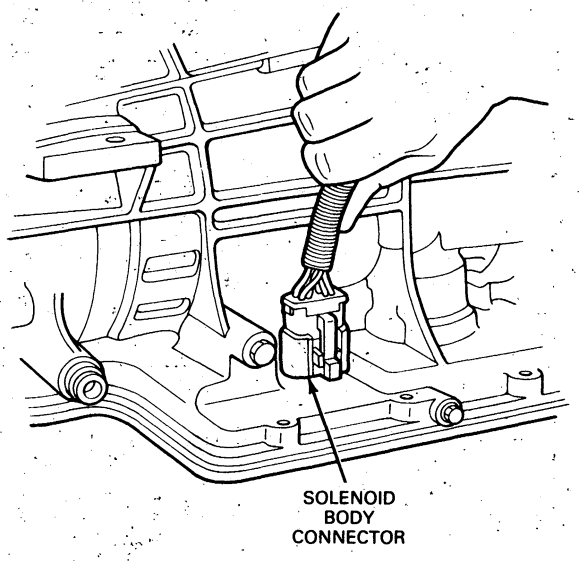
TYPICAL GUSSET INSTALLATION
VIEW Z

D9276-2A

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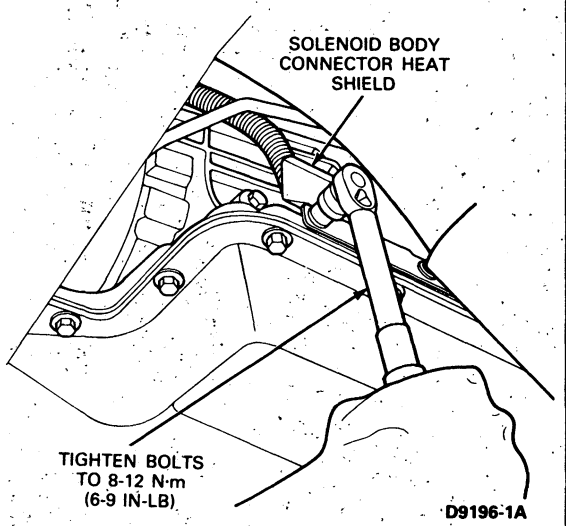
REMOVAL AND INSTALLATION (Continued)

17. Install speedometer cable. Refer to Section 33-02, Speedometer, for cable removal and installation procedures.
18. Completely seat solenoid body connector into solenoid valve body recepticle. An audible click indicates full contact.



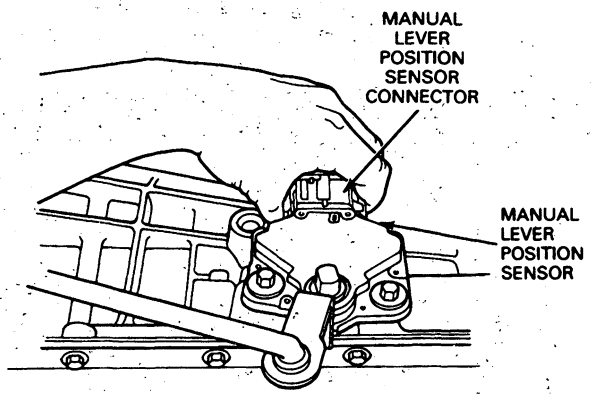
D9195-1A

19. Install solenoid body connector heat shield with off-set bending inward. Tighten to 8-12 N·m (6-9 ft-lbs).



D9196-1A

20. On 4x4 models only, install wire harness locators into crossmember.
21. Install wire harness locator into extension housing wire bracket.
22. On 4x4 models only, install four-wheel drive switch connector.
23. On 4x4 models only, connect transfer case shift linkage. Refer to Section 16-81, Borg-Warner 13-56 Transfer Case—Manual Shift for procedure.
24. Install manual lever position sensor connector. An audible click indicates full connection.



D9160-1A

25. Install shift linkage. Refer to Section 17-02, Shift Control Linkage, for procedure.
26. On 4x4 models only, install shift rod to transfer case shift lever. Refer to Section 16-81, Borg-Warner 13-56 Transfer Case Manual Shift, for procedure.
27. Install rear driveshaft. Refer to Section 15-61, Driveshaft—Single Type U-Joint, for removal procedure.
28. On 4x4 models only, install front driveshaft. Refer to Section 15-67, Front Driveshaft, for installation procedures.
29. Lower vehicle.
30. Connect negative battery cable.
31. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid part no. E4AZ-19582-B, Specification ESP-M2C166-H) or equivalent.

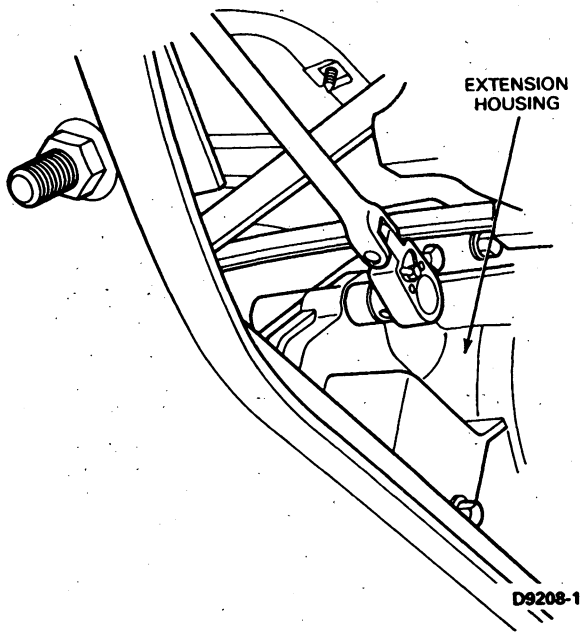
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IN VEHICLE SERVICE

Extension Housing Gasket

Removal

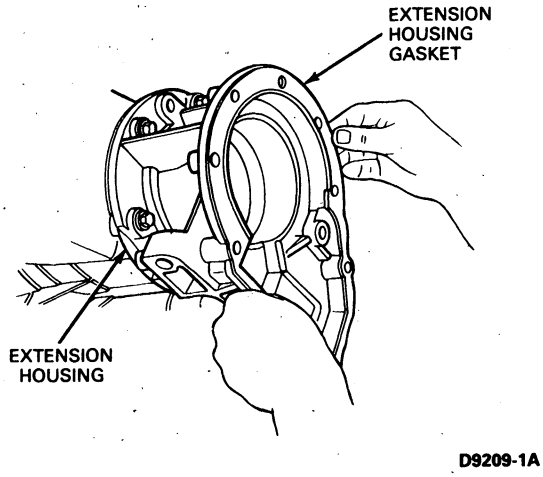
1. Position vehicle on a hoist.
2. Remove front (4x4 only) and rear driveshaft. Refer to Sections 15-67, Front Driveshaft and Section 15-61, Driveshaft—Single Type U-Joint, for removal procedures.
3. Remove transmission mounting pad nuts and bolts. Refer to the transmission removal procedures for crossmember illustrations.
4. On 4x4 models only, remove shift linkage from transfer case shift lever. Refer to the appropriate Sections in Group 16 for transfer case shift linkage removal and installation procedures.
5. On 4x4 models only, remove four-wheel drive switch connector from transfer case, use care not to overextend tabs.
6. Pry wire harness locators from extension housing wire bracket.
7. On 4x4 models only, remove wire harness locators from LH side of crossmember.
8. Remove speedometer cable. Refer to Section 33-02, Speedometer, for Cable Removal and Installation procedures.
9. On 4x4 models only, remove transfer case vent hose from detent place. Refer to the appropriate transfer case section in Group 16 for vent hose location.
10. On 4x4 models only, place Transmission Stand Fixture Rotunda Equipment Model No. 014-00104 or equivalent on universal high lift transmission jack and position under transfer case.
11. Remove nine extension housing bolts using a 13 mm box wrench.



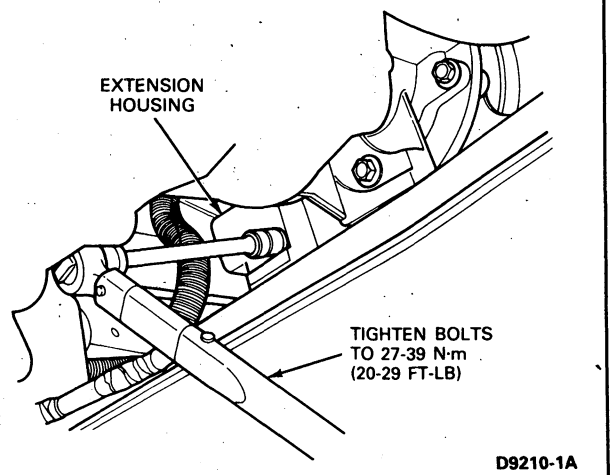
12. Slide transfer case rearward and downward to remove, and discard extension housing gasket from housing and transfer case mating surfaces.

Installation

1. Grease extension housing gasket and position on extension housing.



2. Raise extension housing into position.
3. Install nine extension housing bolts using a 13mm socket. Tighten to 27-39 N·m (20-29 ft-lbs).



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IN VEHICLE SERVICE (Continued)

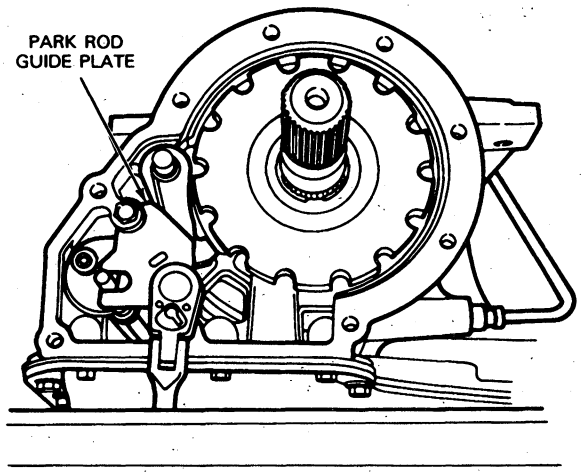
4. On 4x4 models only, attach transfer case vent hose to detent plate. Refer to the appropriate section in Group 16 for vent hose location.
5. On 4x4 models only, install four-wheel drive connector.
6. Install wire harness locator into extension housing wire bracket.
7. Install transmission mounting pad bolts and nuts and tighten to 81-108 N·m (60-80 ft-lbs) for all F Series or 68-96 N·m (50-70 ft-lbs) for all E Series.
8. Remove universal high lift transmission jack.
9. Install speedometer cable. Refer to Section 33-02, Speedometer, for Cable Removal and Installation procedures.
10. Install front (4x4 only) and rear driveshaft. Refer to Section 15-67, Front Driveshaft and Section 15-61, Driveshaft—Single Type U-Joint for removal procedures.
11. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, part no. E4AZ-19582-B, specification (ESP-M2C166-H) or equivalent.

Parking Mechanism

Follow extension housing gasket replacement procedure for removal and installation of extension housing.

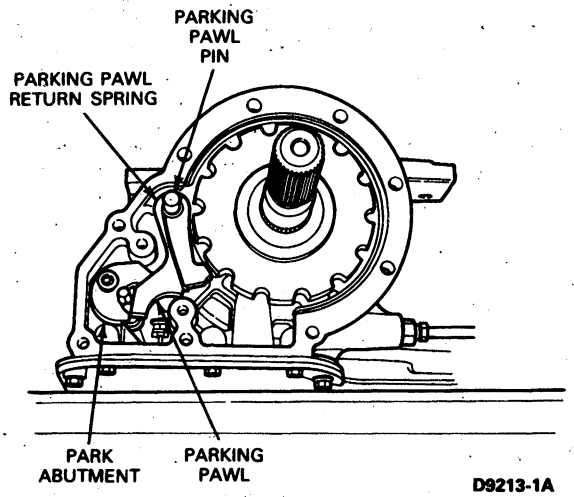
Removal

1. Remove two bolts using a 13mm socket from park rod guide plate.



D9212-1A

2. Remove parking pawl return spring, pin and parking pawl from case.
3. Remove the Torx® head bolt (40A bit) and parking pawl abutment.



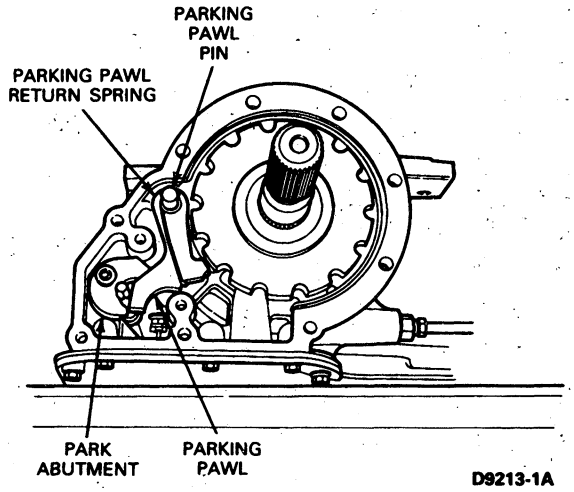
D9213-1A

Installation

1. Install parking pawl, pin and return spring.

NOTE: Spring end rests on inside surface of case.

2. Install parking pawl abutment with Torx® head bolt (40A bit). Tighten to 22-27 N·m (16-20 ft-lbs).



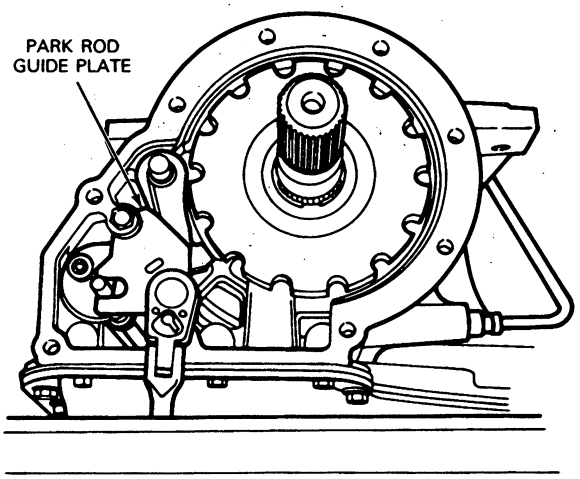
D9213-1A

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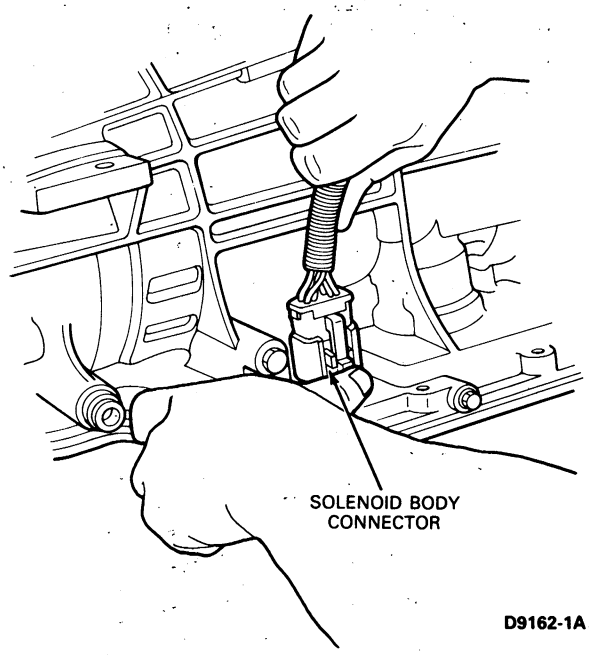
IN VEHICLE SERVICE (Continued)

3. Using a 13mm socket, attach park rod guide plate with two bolts and washers. Tighten to 22-27 N·m (16-20 ft-lbs).

NOTE: Ensure plate dimple is facing inward.



D9212-1A



D9162-1A

- Check electrical connectors for terminal condition, corrosion and contamination. Repair or replace as required.

Valve Body and Intermediate Band Servo

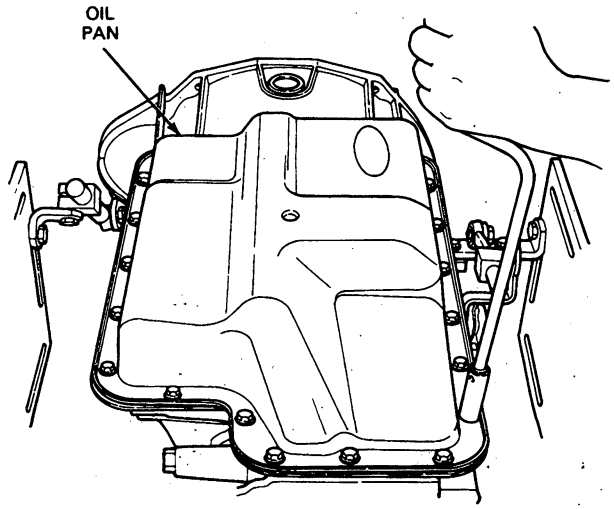
Removal

If solenoid valve body is going to be replaced:

- Remove solenoid body connector heat shield, loosen both bolts using an 8mm socket.
- Remove slotted heat shield.
- Remove solenoid body connector by pushing on the center tab and pulling on the wire harness.

CAUTION: Do not attempt to pry tab with pry bar or screwdriver. Remove the heat shield from the transmission before attempting to remove the connector.

1. Remove 15 back and side pan bolts using a 10mm socket.



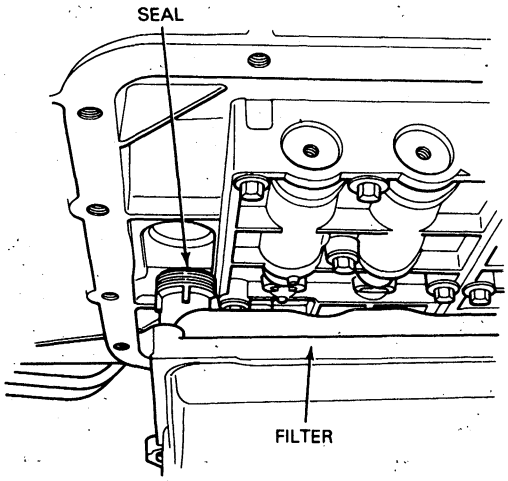
D8954-1A

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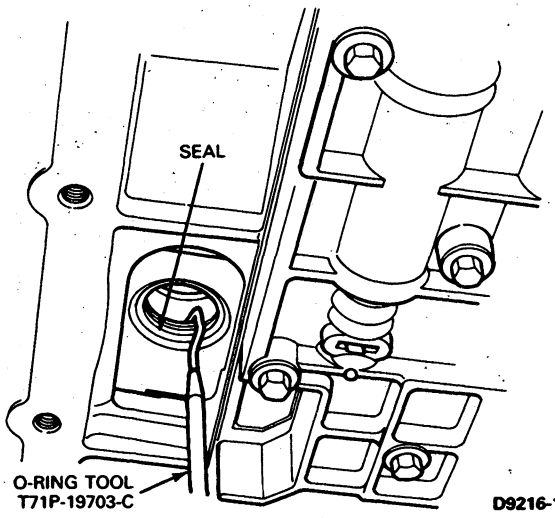
IN VEHICLE SERVICE (Continued)

2. Place a fluid catch basin under transmission pan. Loosen front pan bolts using a 10mm socket. Pry rear of pan from case.
3. Remove front pan bolts using a 10mm socket. Remove pan.
4. Remove filter and seal assembly by carefully pulling and rotating the filter as necessary. If seal remains in bore, carefully remove using O-Ring Tool T71P-19703-C or equivalent.

NOTE: Discard filter and seal.

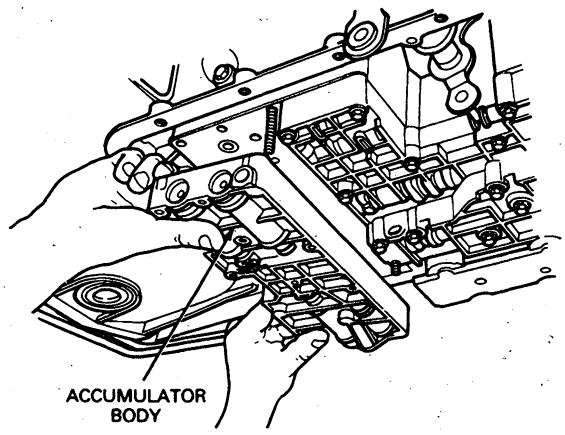


D9215-1A



D9216-1A

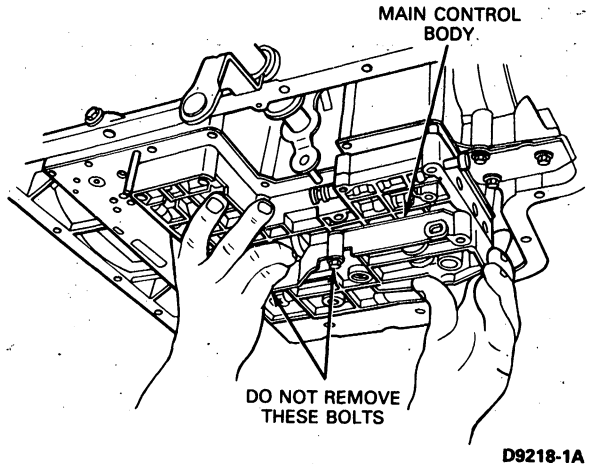
5. Remove 11 accumulator body bolts using an 8mm socket and two nuts using a 10mm socket. Remove accumulator body.



D9217-1A

6. Remove 14 main control body bolts using an 8mm socket and two nuts using a 10mm socket. Remove main control body.

NOTE: Do not remove the two bolts as shown on illustration.

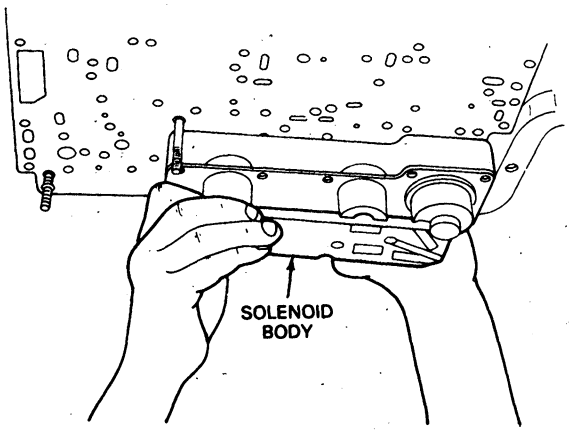


D9218-1A

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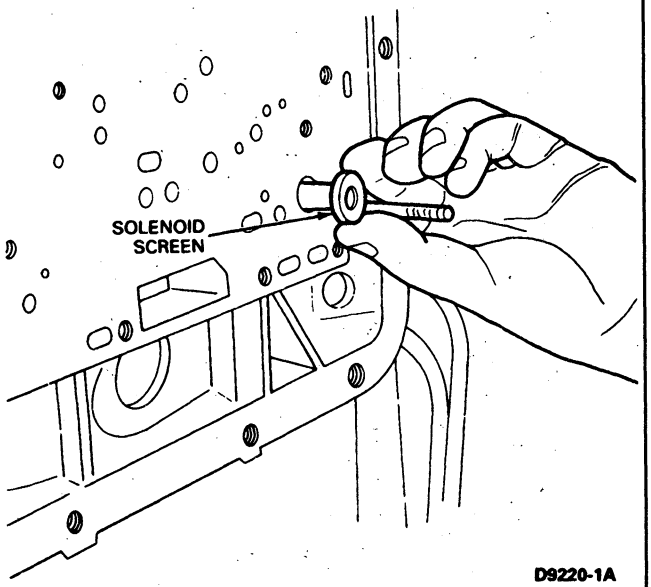
IN VEHICLE SERVICE (Continued)

7. Remove nine solenoid body bolts using a 30A Torx® bit and one nut using a 10mm socket. Push down on solenoid body receptacle to remove solenoid body.



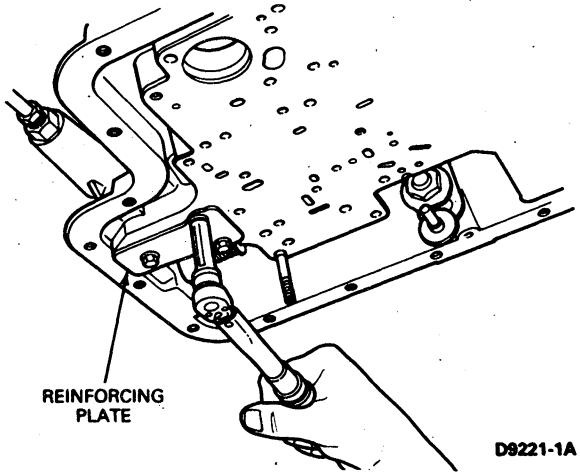
D9219-1A

8. Remove solenoid screen by turning counterclockwise and pulling out.



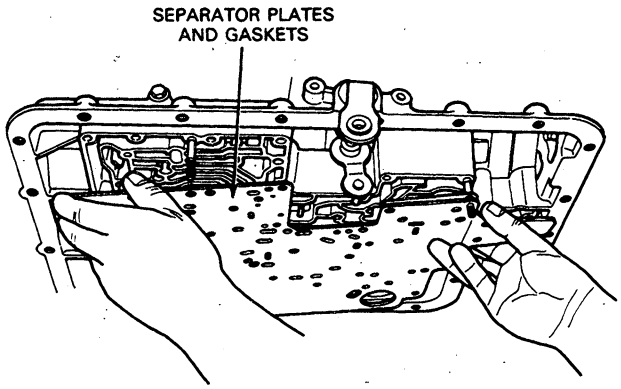
D9220-1A

9. Remove three reinforcing plate bolts using an 8mm socket. Remove plate.



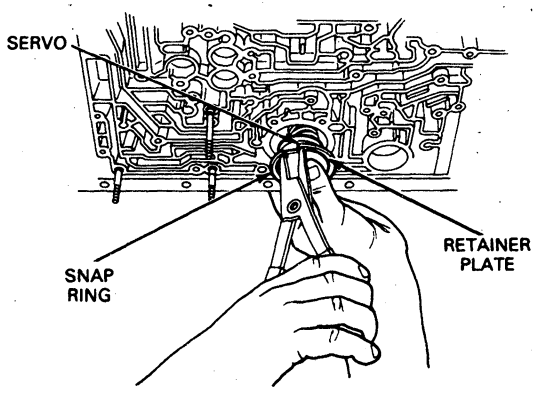
D9221-1A

10. Carefully lower separator plate and gasket so that check balls, EPC ball and spring are retained.



D9222-1A

11. Remove servo snap ring and retaining plate, piston and rod assembly and servo spring.



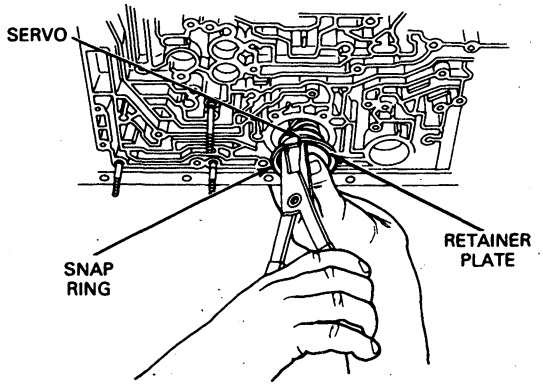
D9223-1A

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IN VEHICLE SERVICE (Continued)

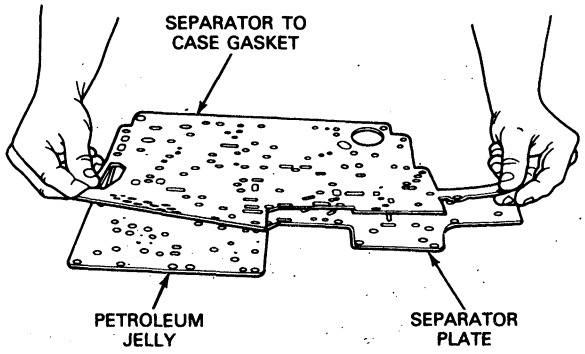
Installation

1. Install servo spring, servo piston and rod assembly.
2. Install servo retaining plate and snap ring.



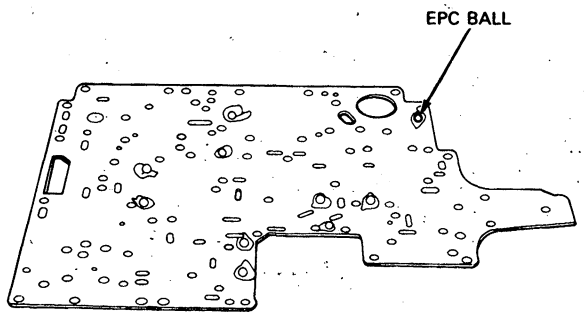
D9223-1A

3. Grease separator plate with petroleum jelly to hold new separator to control gasket.



D9224-1A

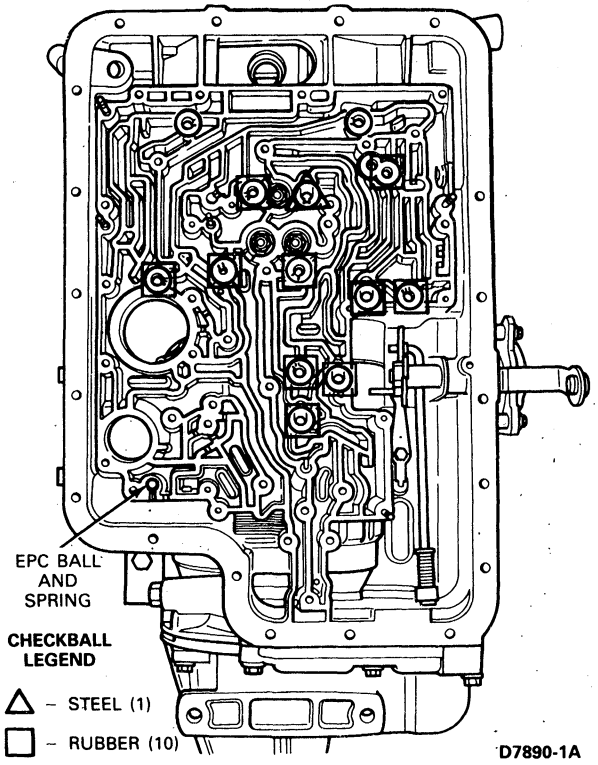
4. Position new separator to case gasket on separator plate.
5. Lubricate separator case gasket with petroleum jelly as shown.



11 CHECK BALL LOCATIONS

D9225-2A

6. Grease valve body pockets with petroleum jelly as shown. Put 11 check balls (10 rubber and 1 steel), EPC spring and greased EPC ball into position.



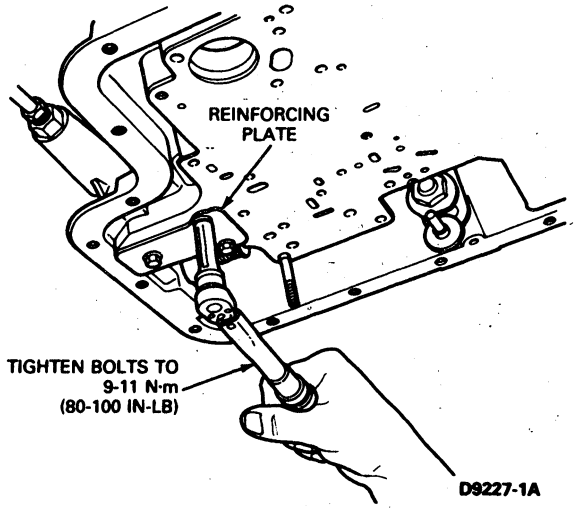
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IN VEHICLE SERVICE (Continued)

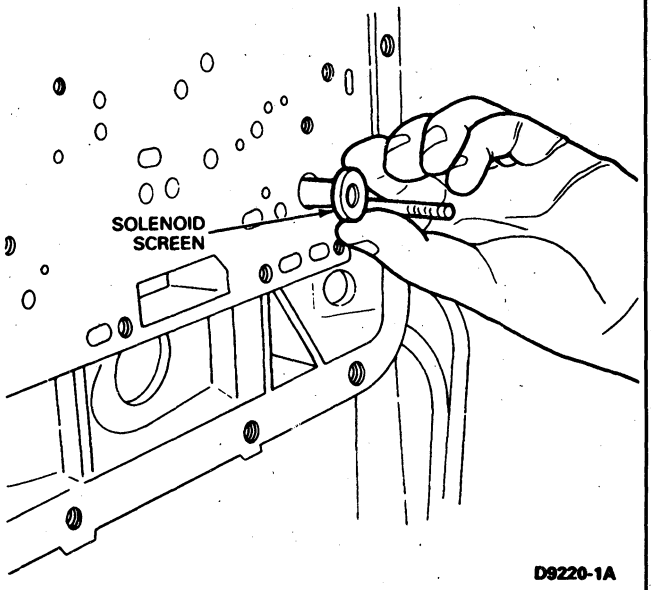
7. Install separator plate and gaskets. Install three reinforcing plate bolts using an 8mm socket. Tighten to 9- 11 N·m (80-100 in-lbs).

NOTE: Check location of check balls and EPC ball.

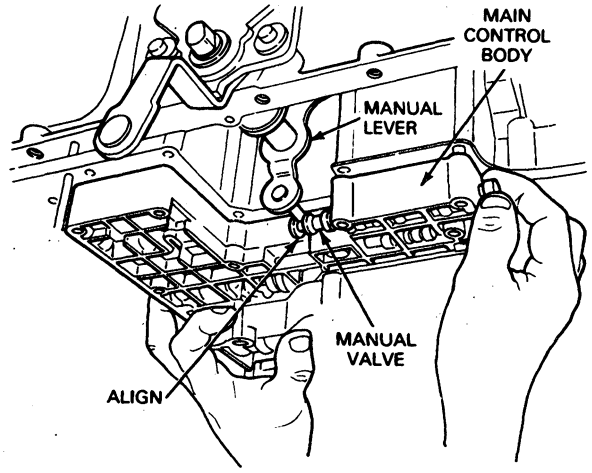


NOTE: Stamped "UP" on reinforcing plate must be visible.

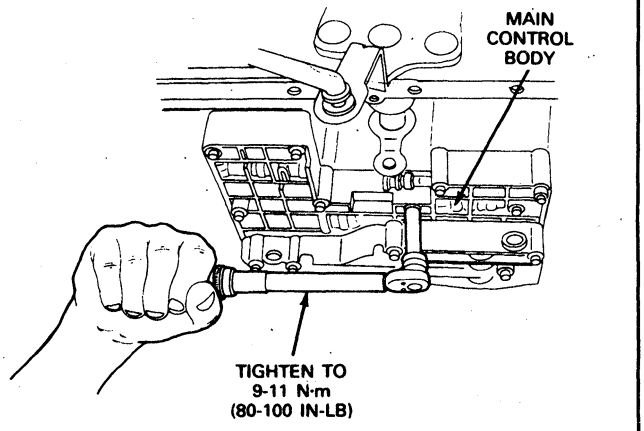
8. Install solenoid screen and lock in place by turning clockwise.



9. Install main control body over studs. Align manual valve with manual lever.



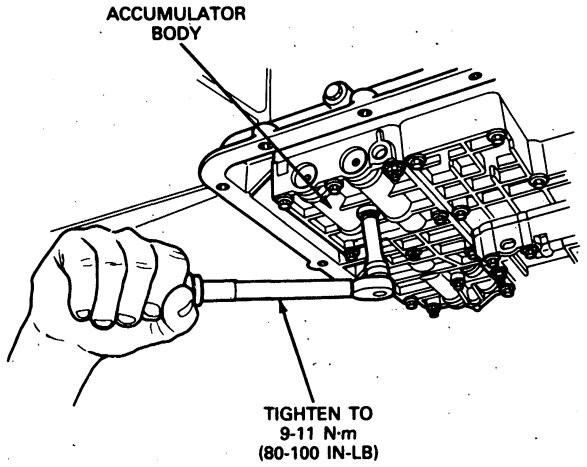
10. Attach valve body with two nuts using a 10mm socket and 14 bolts using an 8mm socket. Tighten to 9-11 N·m (80-100 in-lb).



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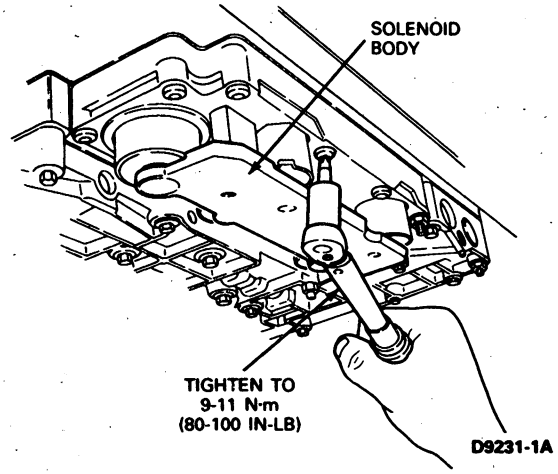
IN VEHICLE SERVICE (Continued)

11. Install accumulator body over studs and attach with two nuts using a 10mm socket and 11 bolts using an 8mm socket. Tighten to 9-11 N·m (80-100 in-lb).

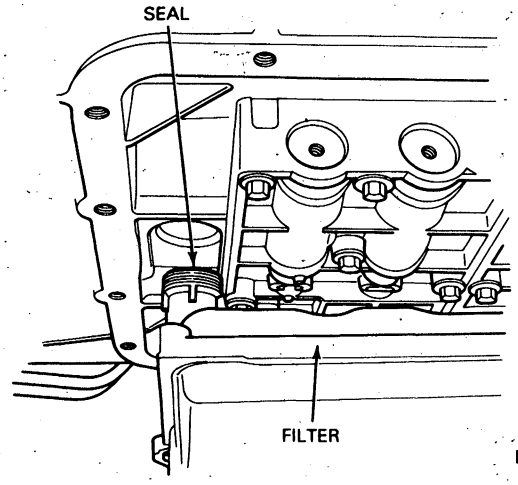


12. Install solenoid body over stud and attach with nine Torx® bolts using a 30A bit and one nut using a 10mm socket. Tighten to 9-11 N·m (80-100 in-lb).

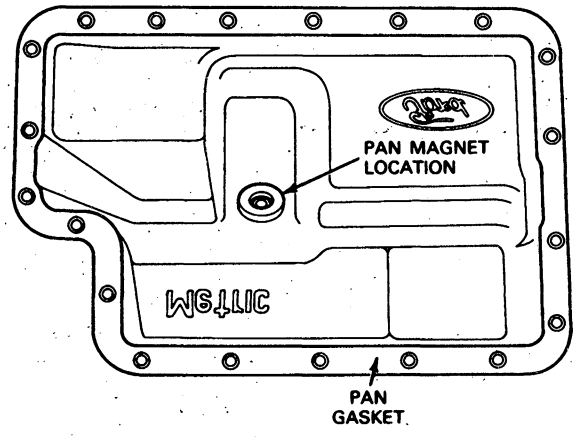
NOTE: Prior to solenoid body assembly installation, coat the case connector bore with M1C172-A grease or equivalent.



13. Install a new filter and seal assembly by lubricating the seal with transmission fluid and pressing the filter into place. Do not reuse filter or seal.



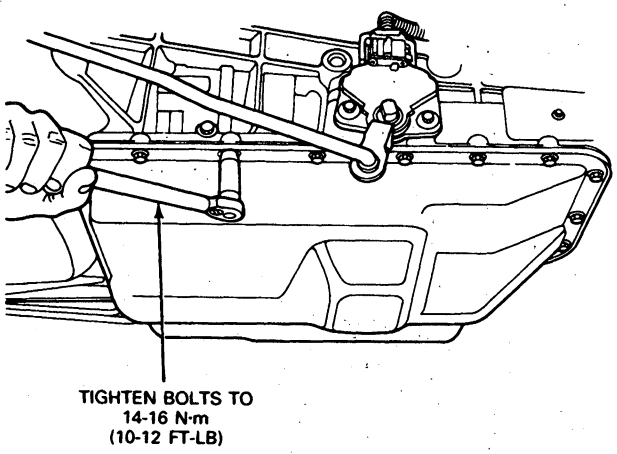
14. Using grease to hold new pan gasket, position gasket onto pan. Check condition and placement of pan magnet.



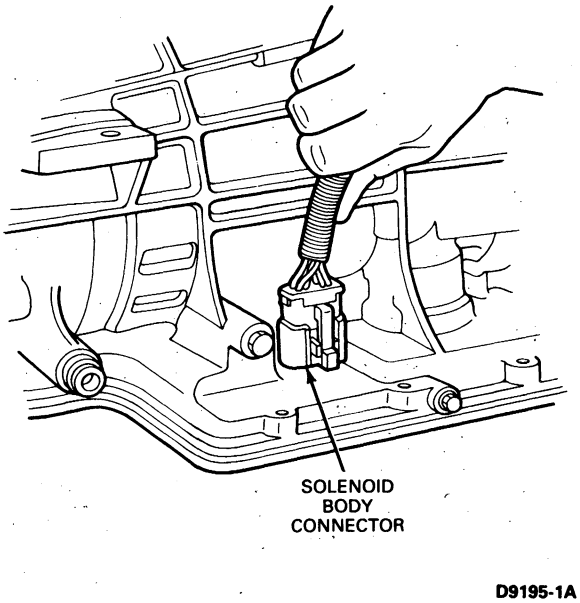
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IN VEHICLE SERVICE (Continued)

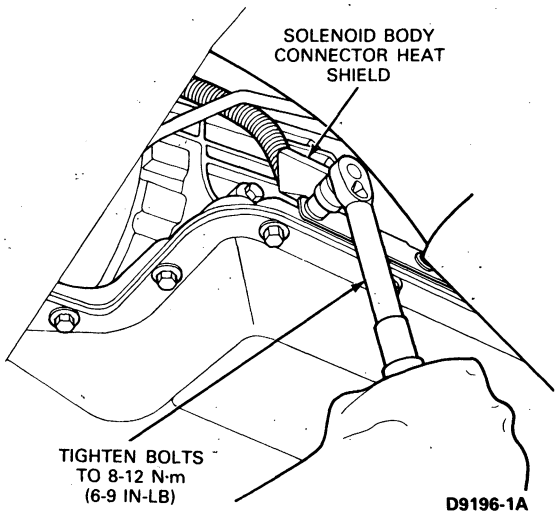
15. Install 20 pan bolts using a 10mm socket. Tighten to 14-16 N·m (10-12 ft-lb).



16. Completely seat solenoid body connector into solenoid valve body receptacle. Audible click indicates full connection.



17. Install solenoid body connector heat shield with off-set bending inward. Tighten to 8-12 N·m (6-9 ft-lb).

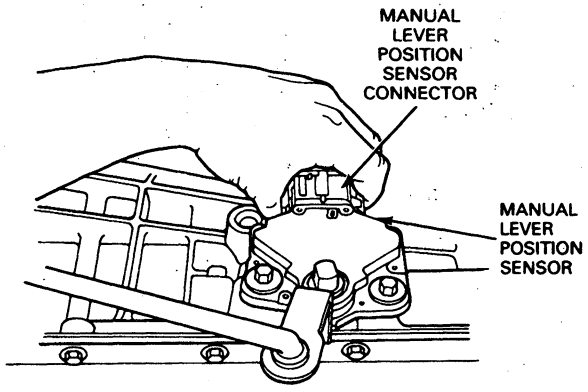


18. Lower vehicle.
19. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, part no. E4AZ-19582-B, specification ESP-M2C166-H or equivalent.

Manual Lever Seal

Removal

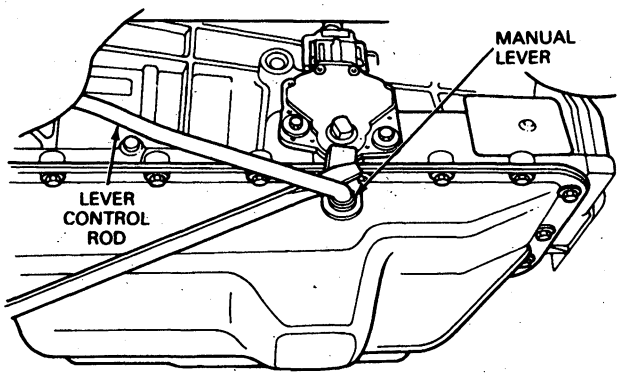
1. Remove manual lever position sensor connector by squeezing connector tabs and pulling on connector harness.



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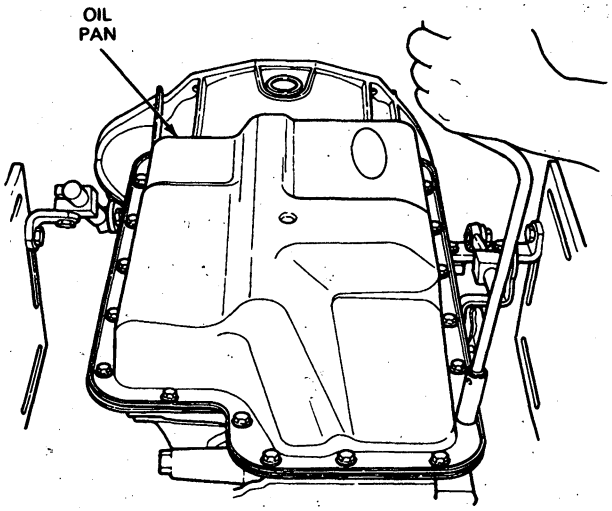
IN VEHICLE SERVICE (Continued)

2. Check electrical connectors for terminal condition, corrosion and contamination. Repair or replace as required.
3. Remove lever control rod from manual lever using a large screwdriver.



D9157-1A

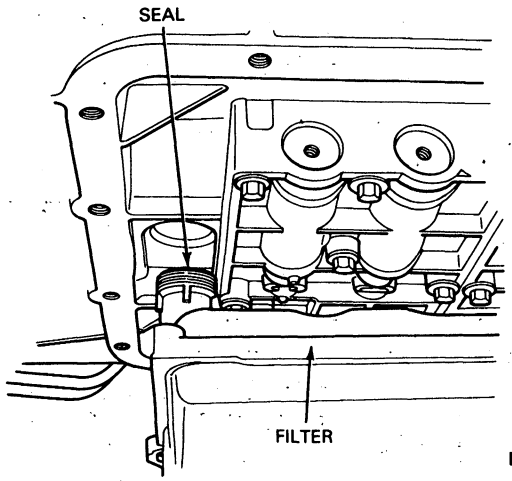
4. Remove two manual lever position sensor bolts using an 8mm socket and sensor.
5. Place a fluid catch basin under transmission pan. Remove 15 back and side pan bolts using a 10mm socket.



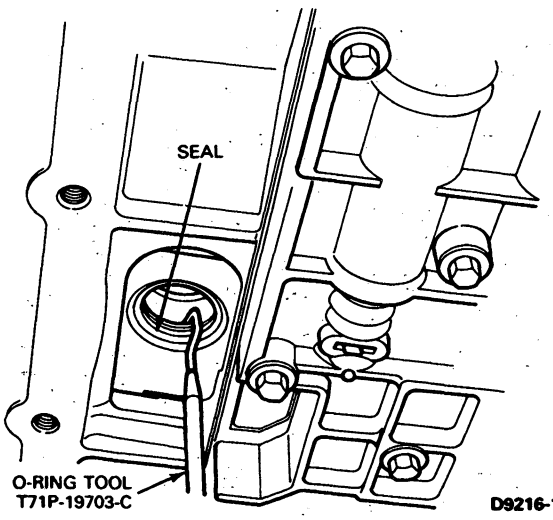
D8954-1A

6. Loosen front pan bolts using a 10mm socket. Pry rear of pan from case, and allow fluid to drain.
7. Remove front pan bolts using a 10mm socket. Remove pan.
8. Remove filter and seal assembly by carefully pulling and rotating filter as necessary. If seal remains in bore, carefully remove using O-Ring Tool T71P-19703-C or equivalent.

NOTE: Discard filter and seal assembly.



D9215-1A

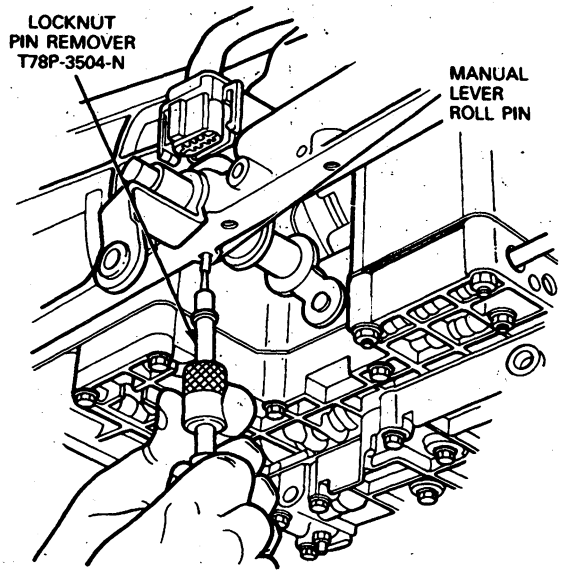


D9216-1A

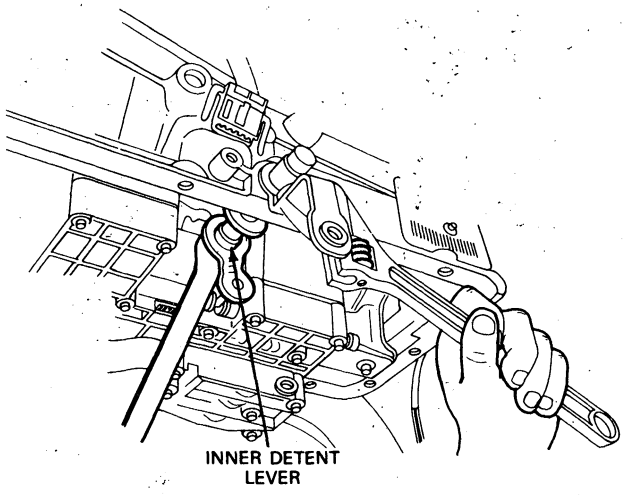
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IN VEHICLE SERVICE (Continued)

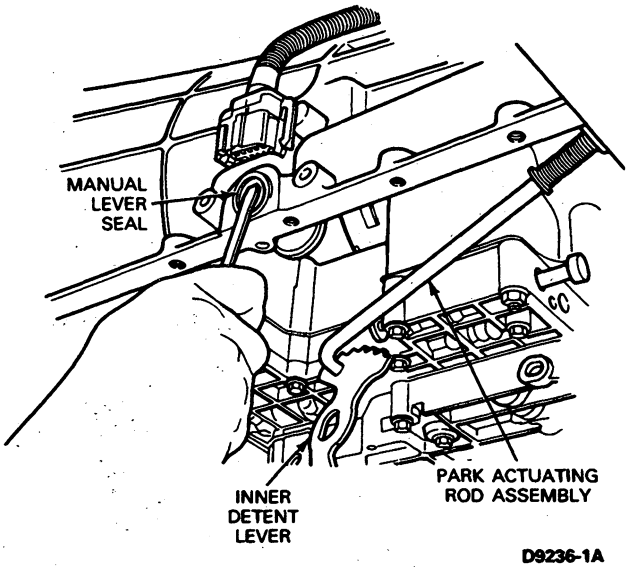
9. Remove manual lever roll pin using Locknut Pin Remover T78P-3504-N or equivalent.



10. Remove inner detent lever nut using a 21mm box wrench while holding lever with crescent wrench.

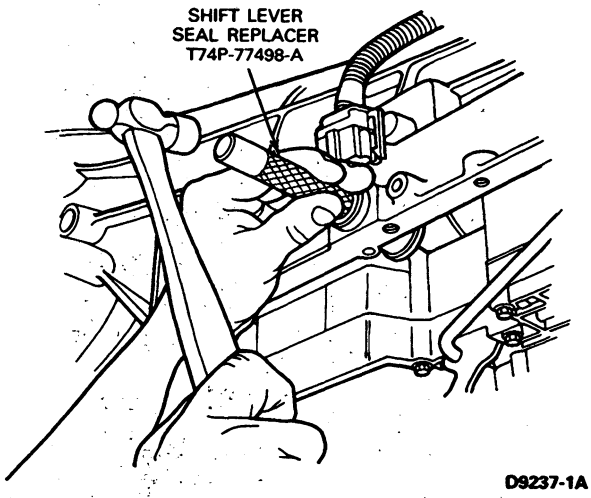


11. Remove inner detent lever and park actuating rod assembly from manual lever.
12. Remove manual lever.
13. Remove manual lever seal using a large screwdriver, being careful not to score bore.



Installation

1. Clean bore opening with mineral spirits. Install seal using Shift Lever Seal Replacer T74P-77498-A or equivalent.

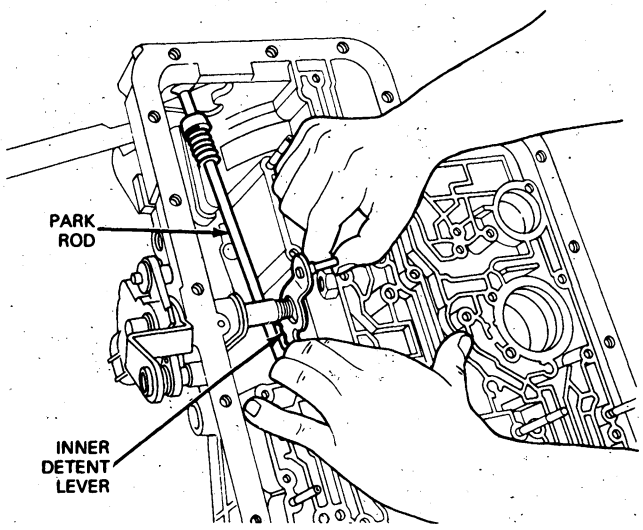


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IN VEHICLE SERVICE (Continued)

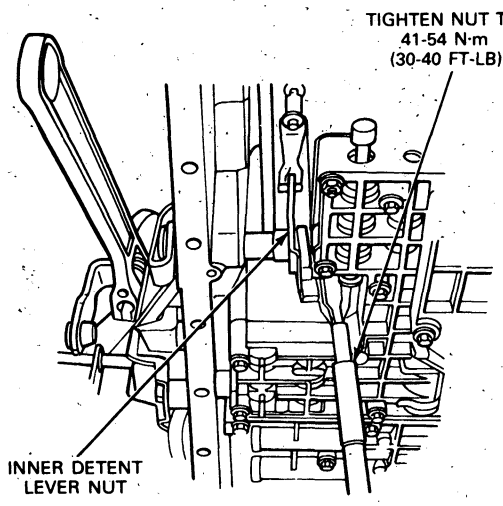
2. Install manual lever, inner detent lever, park actuating rod assembly and nut using a 21mm box wrench.

NOTE: Inner detent lever must be sealed on flats of shaft, and rod assembly must be through guide plate. Inner lever pin must be aligned with manual lever.



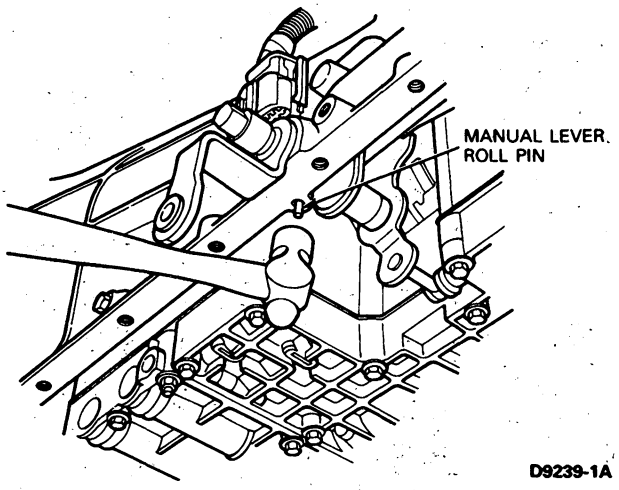
D7876-1A

3. Tighten inner detent lever nut using a 21mm crows foot while holding lever with crescent wrench. Tighten to 41-54 N·m (30-40 ft-lb).



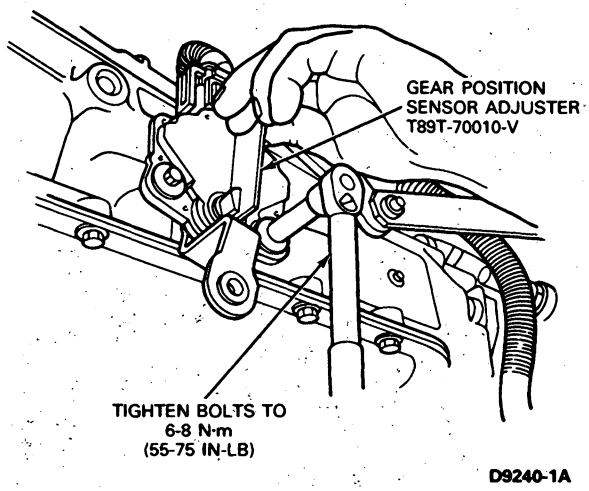
D9238-1A

4. Install manual lever roll pin.



D9239-1A

5. Install manual lever position sensor with two bolts and washers. Do not tighten bolts at this time. Align manual lever position sensor for NEUTRAL gear position using Gear Position Sensor Adjuster T89T-70010-J or equivalent.
6. Using an 8mm socket, tighten bolts to 6-8 N·m (55-75 i-lbs).

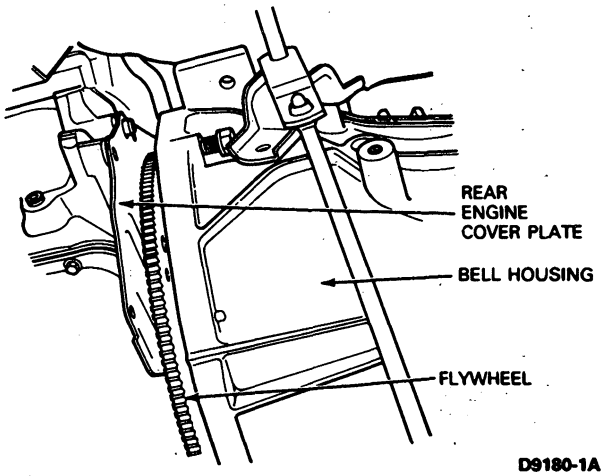


D9240-1A

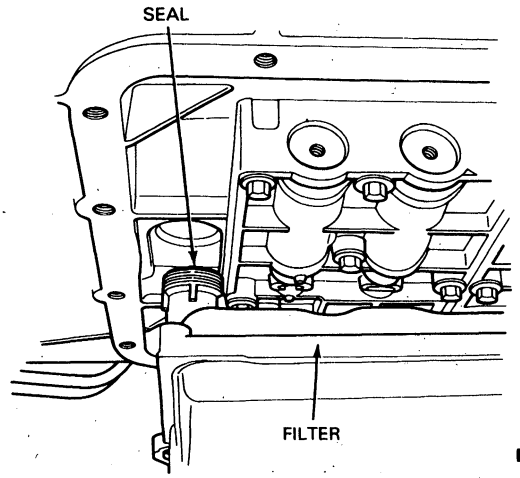
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IN VEHICLE SERVICE (Continued)

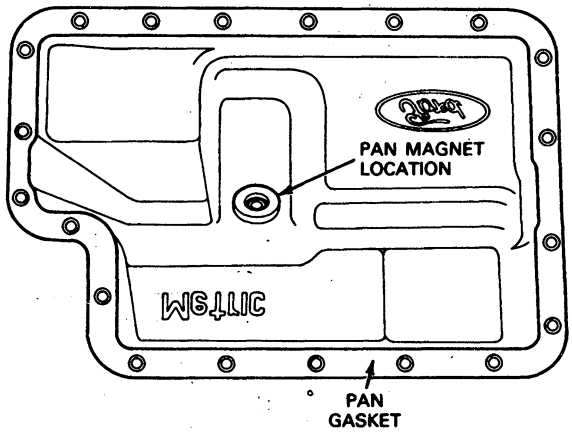
7. Install manual lever position sensor connector. Audible click indicates full connection.



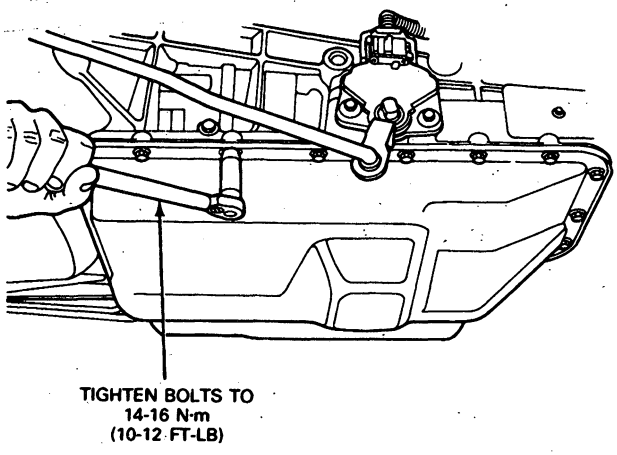
8. Install shift linkage. For procedure, refer to Shift Control Linkage, Section 17-02.
9. Install a new filter and seal assembly by lubricating the seal with transmission fluid and pressing the filter into place. Do not reuse old filter or seal.



10. Using grease to hold new pan gasket, position gasket onto pan. Check condition and placement of pan magnet.



11. Install pan and 20 pan bolts using a 10mm socket. Tighten to 14-16 N·m (10-12 ft-lb).



12. Lower vehicle.
13. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, part no. E4AZ-19582-B, specification ESP-M2C166-H or equivalent.

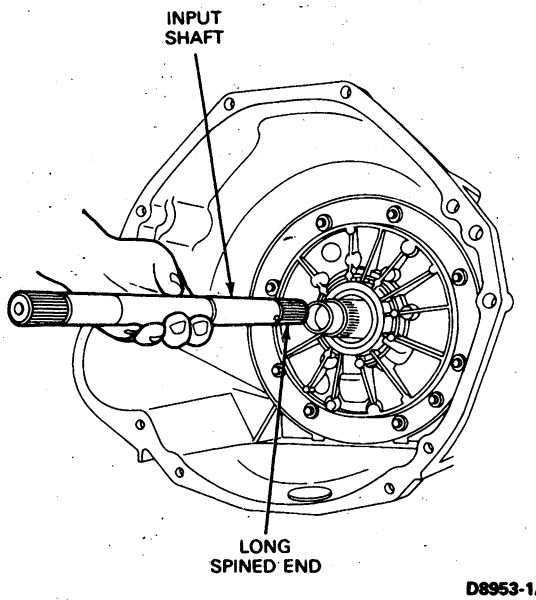
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DISASSEMBLY AND ASSEMBLY

Refer to the transmission disassembled view at the beginning of this Section.

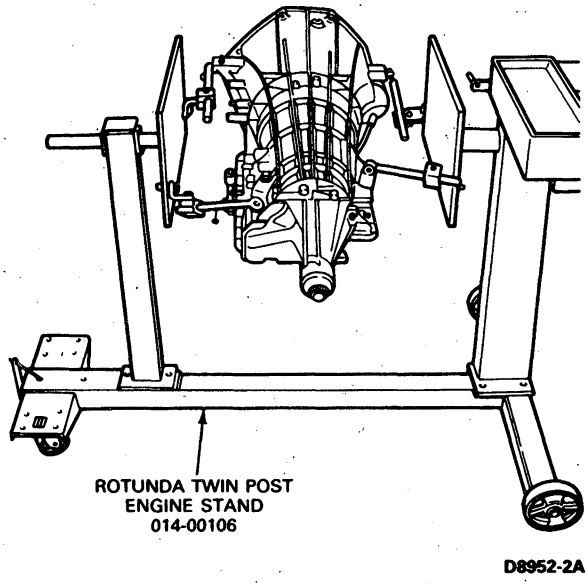
Disassembly

1. Remove input shaft from transmission.

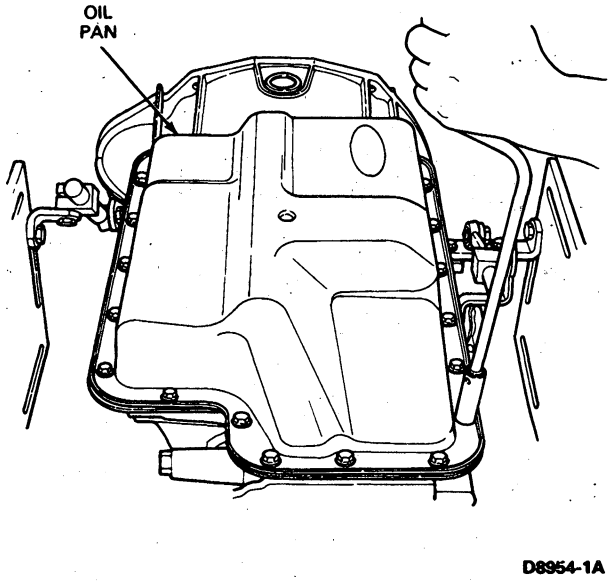


2. Mount transmission on Twin Post Engine Stand Rotunda 014-00106 or equivalent.

NOTE: Thoroughly clean the solenoid body connector area to avoid contamination.

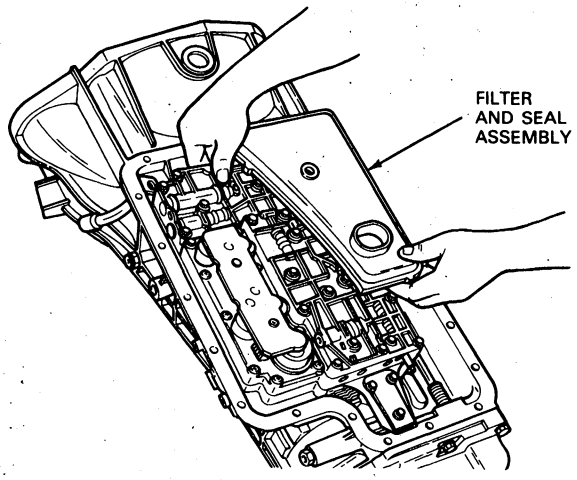


3. Rotate transmission so that pan is facing up. Remove 20 pan attaching bolts (10mm socket). Remove the pan and gasket, discard gasket.



4. Remove filter and seal assembly by carefully pulling and rotating filter as necessary. If seal remains in bore, carefully remove using O-Ring Tool T71P-19703-C or equivalent.

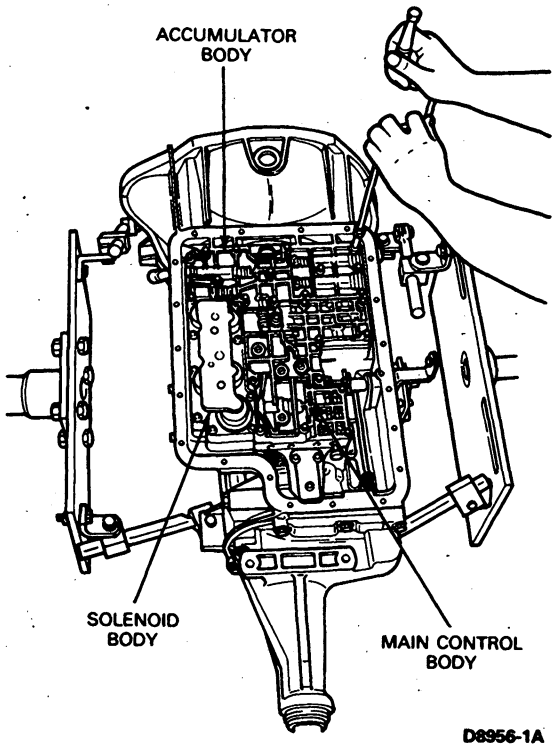
NOTE: Discard filter and seal.



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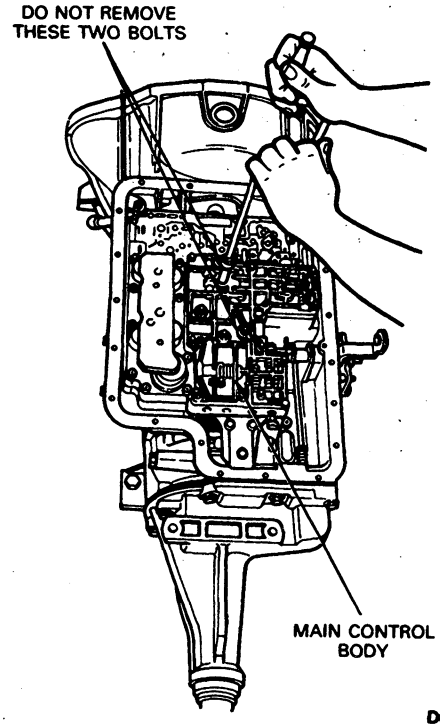
DISASSEMBLY AND ASSEMBLY (Continued)

5. Remove accumulator body, 11 bolts (8mm socket) and two nuts (10mm socket).

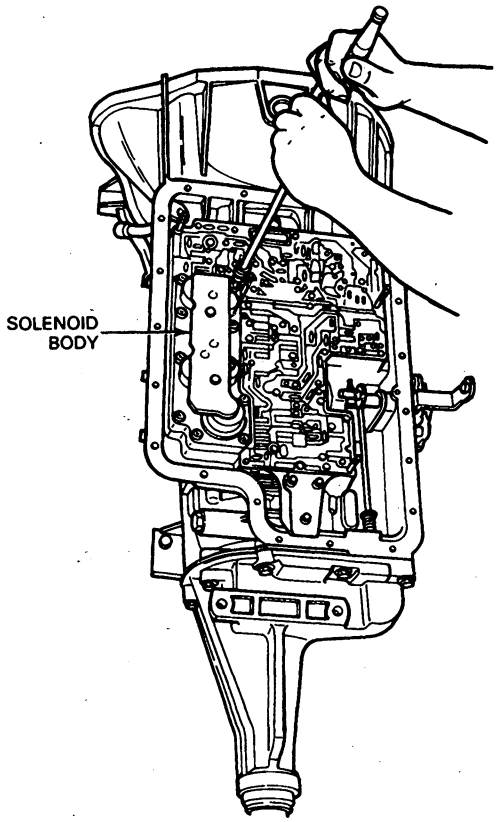


6. Remove main control body 14 bolts (8mm socket) two nuts (10mm socket).

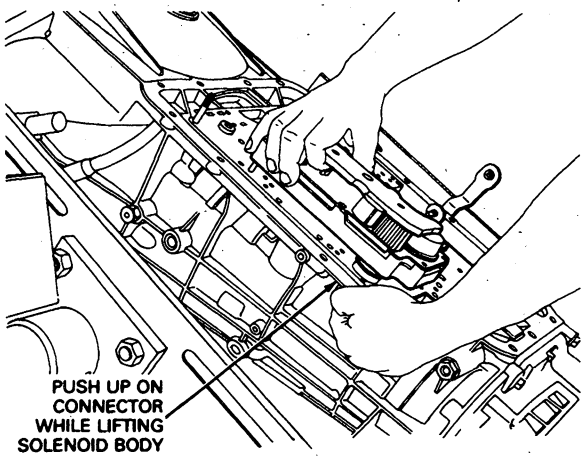
NOTE: Do not remove the two bolts as shown.



7. Remove nine solenoid body bolts (30A Torx® bit) and one nut (10mm socket).



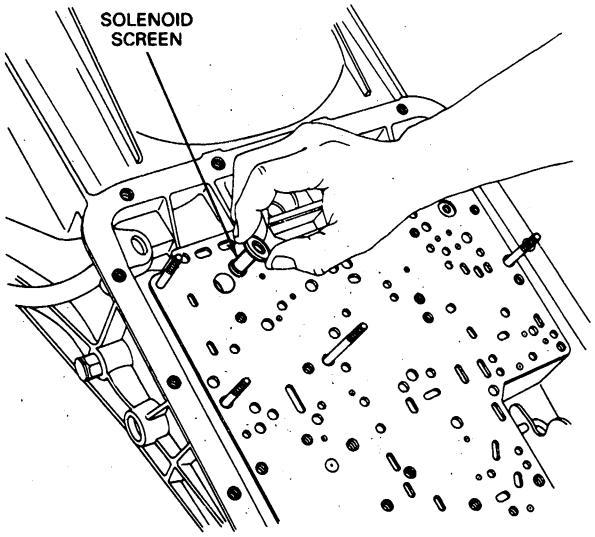
8. Push up on solenoid body connector while removing solenoid body.



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DISASSEMBLY AND ASSEMBLY (Continued)

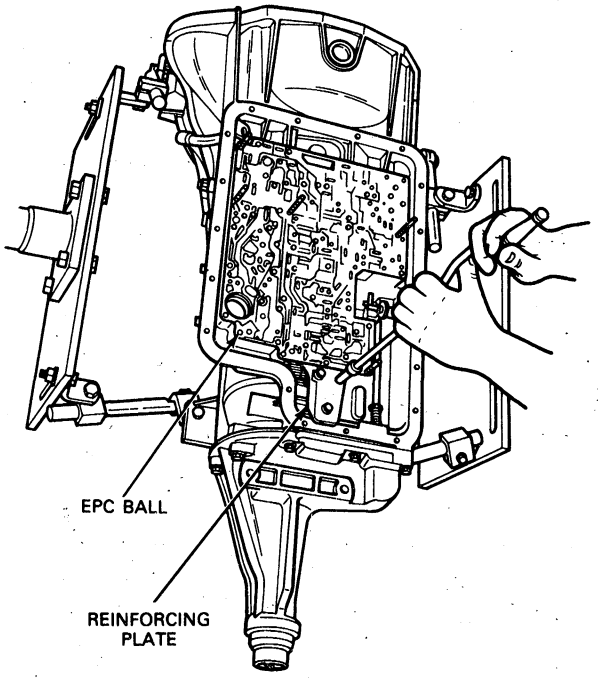
9. Remove solenoid screen, by turning counterclockwise and pull out.



D8960-1A

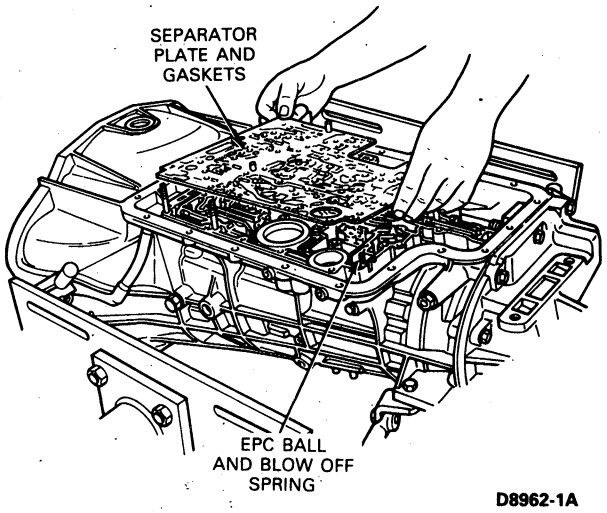
10. Remove three reinforcing plate bolts (8mm socket), remove plate.

NOTE: EPC ball is spring loaded under separator plate.



D8961-1A

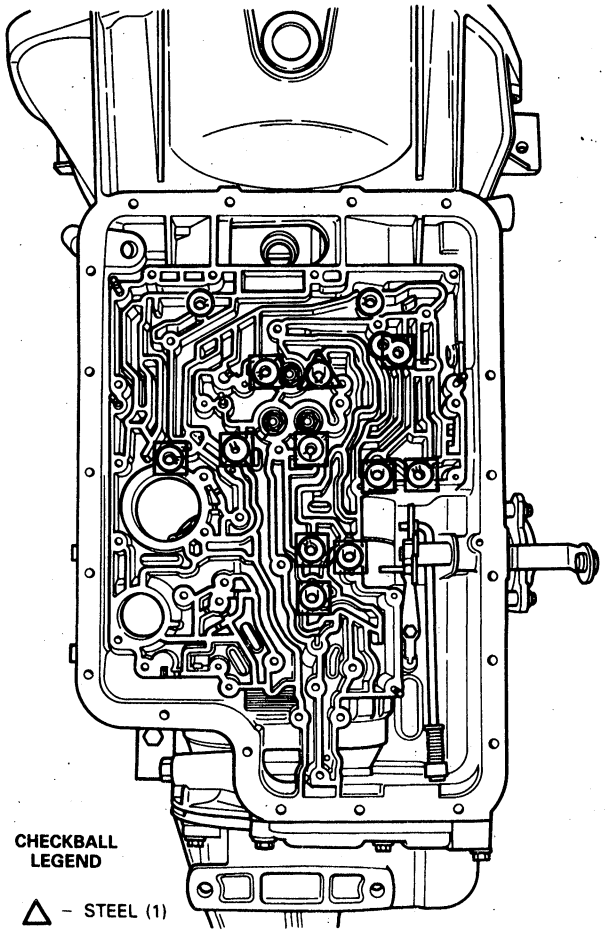
11. Remove separator plate, two gaskets, EPC ball and blowoff spring, discard gasket.



D8962-1A

12. Remove one steel and ten rubber check balls from transmission, using a small screwdriver.

CAUTION: Do not mar rubber check balls.



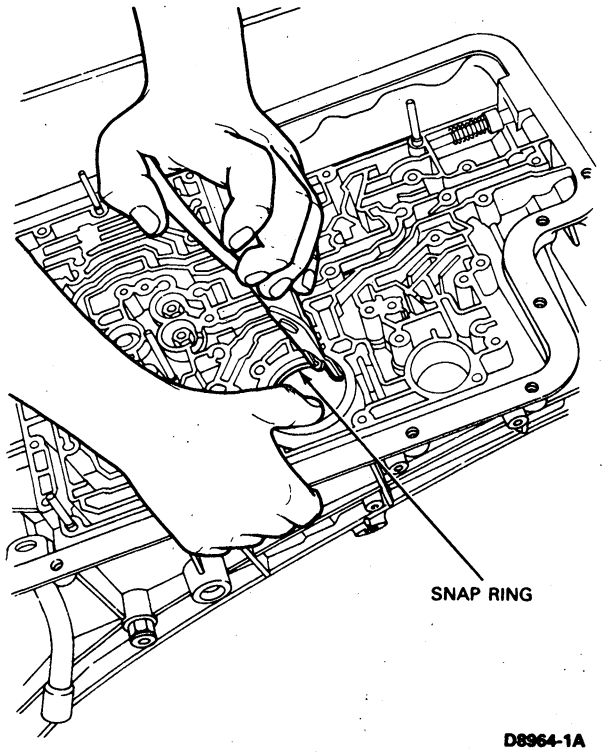
D9040-1A

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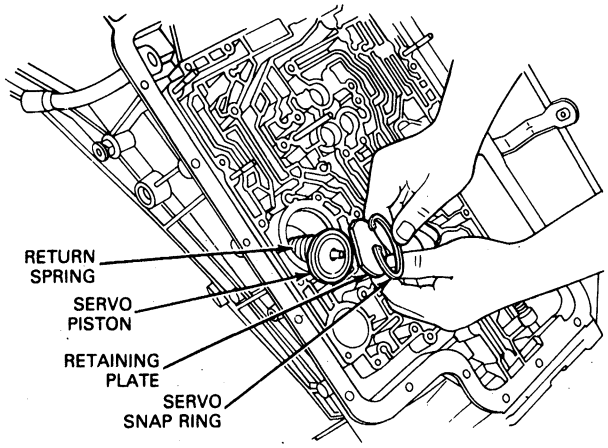
DISASSEMBLY AND ASSEMBLY (Continued)

13. Remove servo snap ring and retaining plate, piston and rod assembly and servo spring.

NOTE: Apply slight downward pressure to plate while removing snap ring.

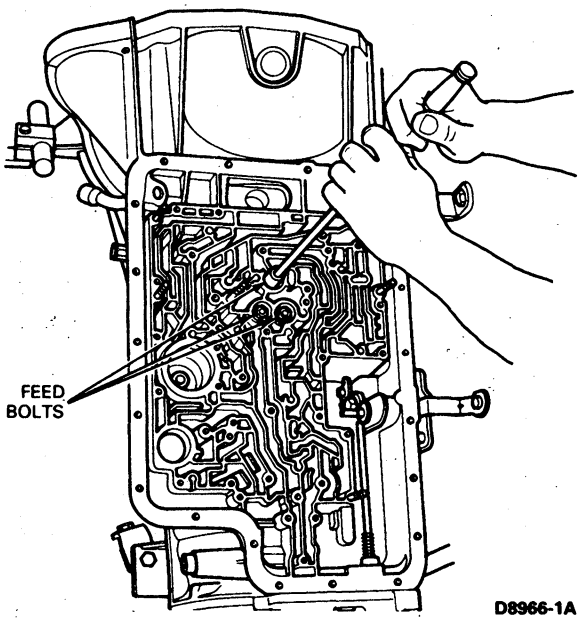


D8964-1A



D8965-1A

14. Remove three feed bolts (13mm socket). Discard feed bolts.

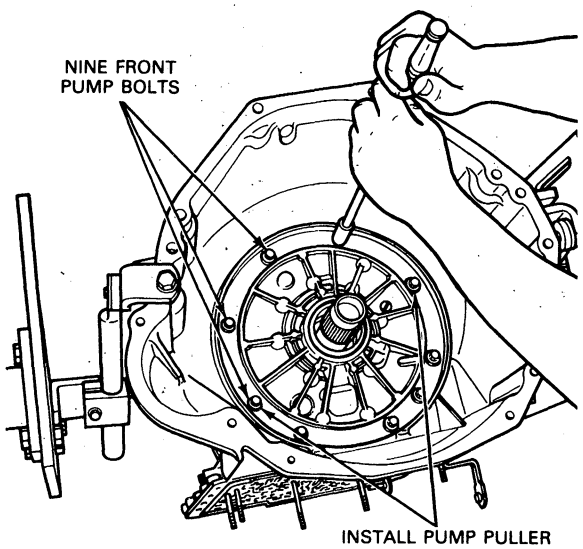


D8966-1A

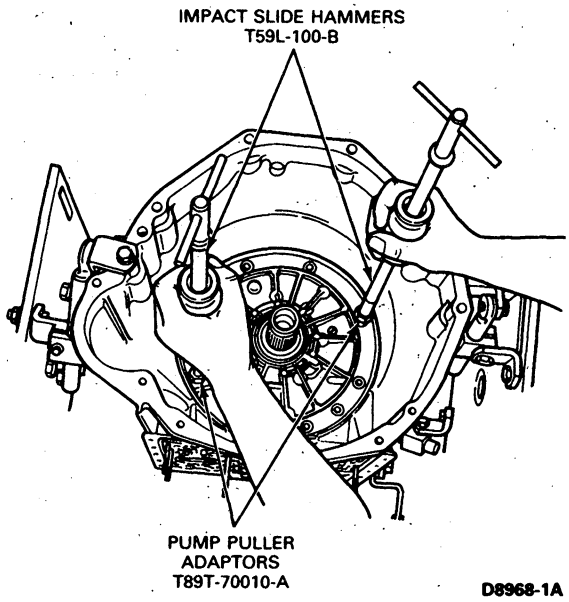
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DISASSEMBLY AND ASSEMBLY (Continued)

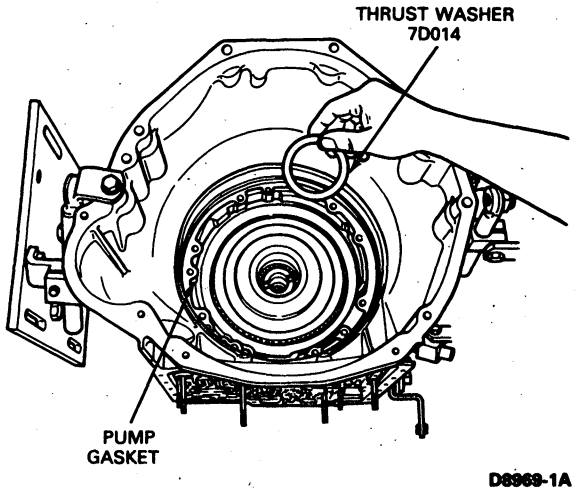
15. Rotate transmission so that bell housing is facing up. Remove nine pump bolts, (10mm socket). Discard pump bolt washers.



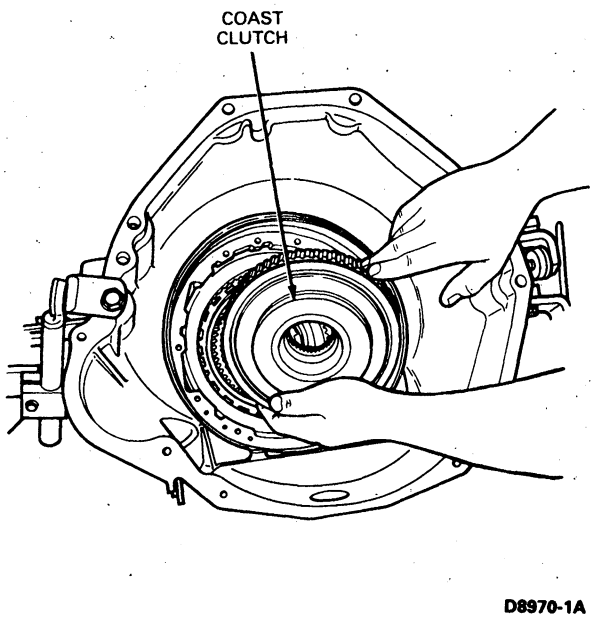
16. Use two threaded holes in pump and install Pump Puller Adapter T89T-70010-A or equivalent. Install Slide Hammer T59L-100-B or equivalent into adapter and remove pump.



17. Remove pump gasket and No. 7D014 thrust washer. Discard gasket.



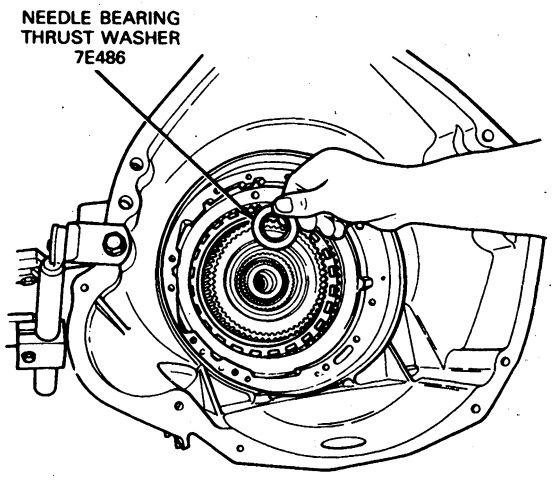
18. Lift out the coast clutch assembly.



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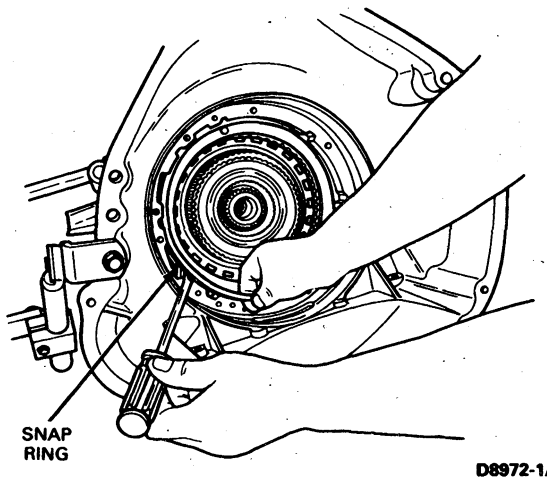
DISASSEMBLY AND ASSEMBLY (Continued)

19. Remove needle bearing assembly 7E486 between front pump and sun gear.



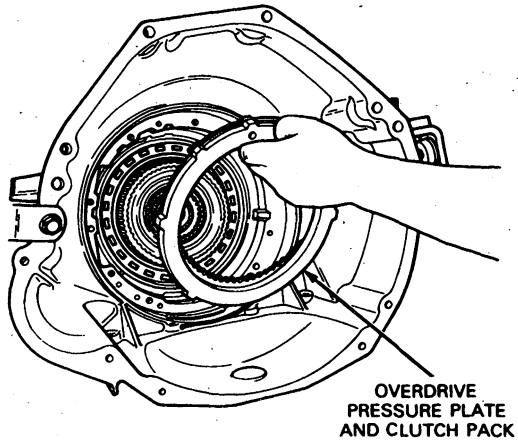
D8971-1A

20. Remove large snap ring using large screwdriver.



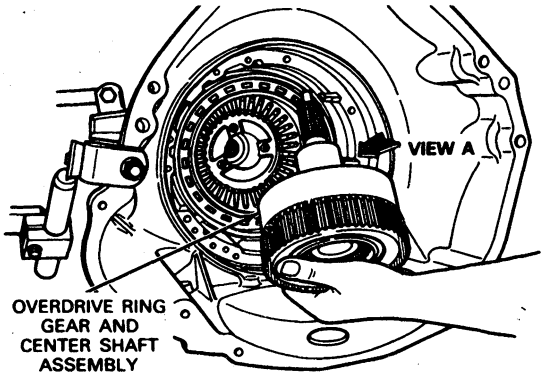
D8972-1A

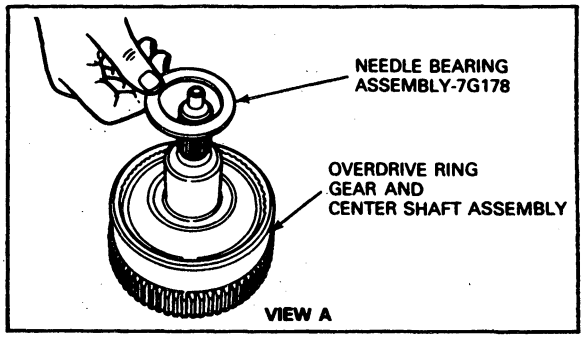
21. Remove overdrive pressure plate and clutch pack and tag for re-assembly.



D8973-1A

22. Remove overdrive ring gear and center shaft assembly and needle bearing assembly 7G178.



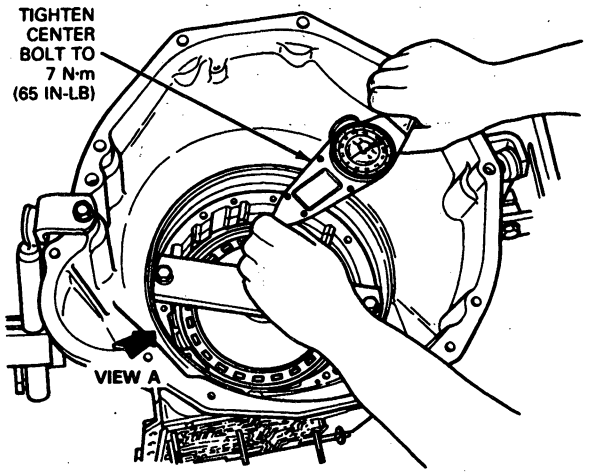


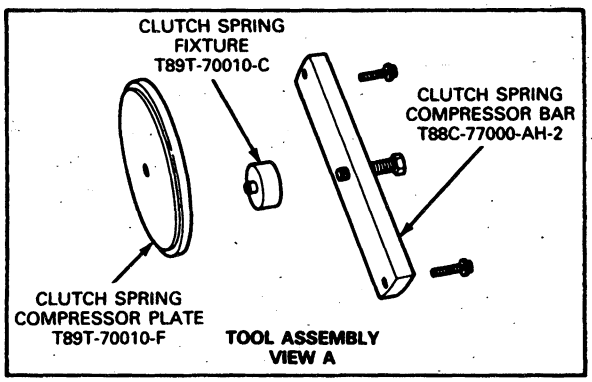
D8974-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

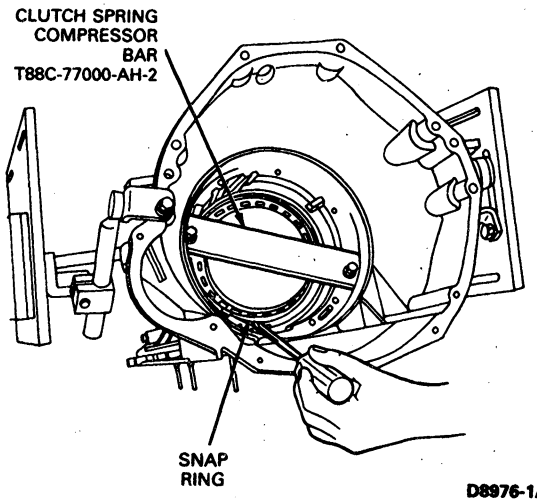
23. Install Clutch Spring Compressor T89T-70010-F or equivalent into the case. Tighten center bolt to 7 N·m (65 in-lbs).





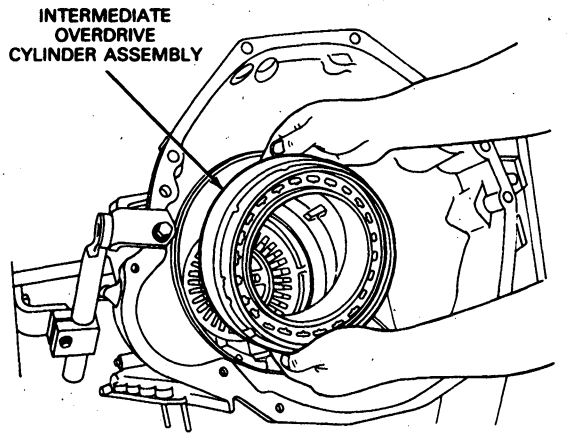
D8975-1A

24. Remove large snap ring with large screwdriver. Loosen spring compressor center bolt and remove compressor tool.



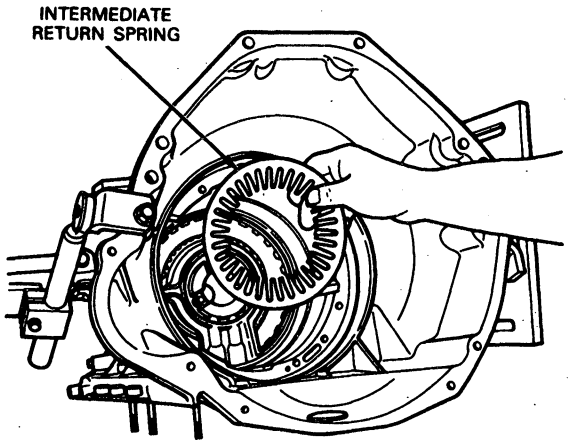
D8976-1A

25. Remove intermediate/overdrive cylinder assembly.



D8977-1A

26. Remove intermediate return spring.

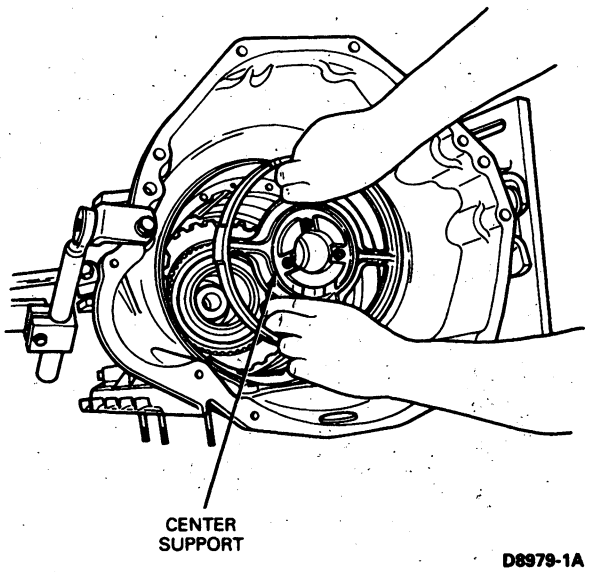


D8978-1A

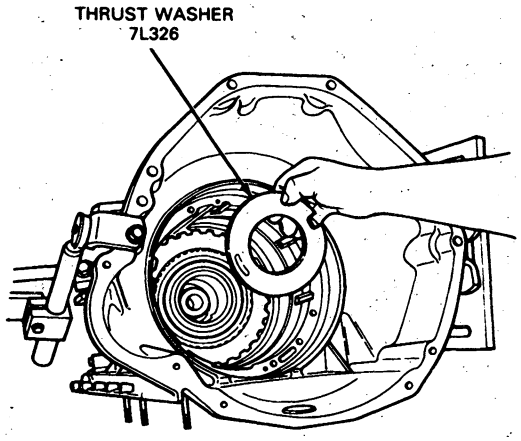
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DISASSEMBLY AND ASSEMBLY (Continued)

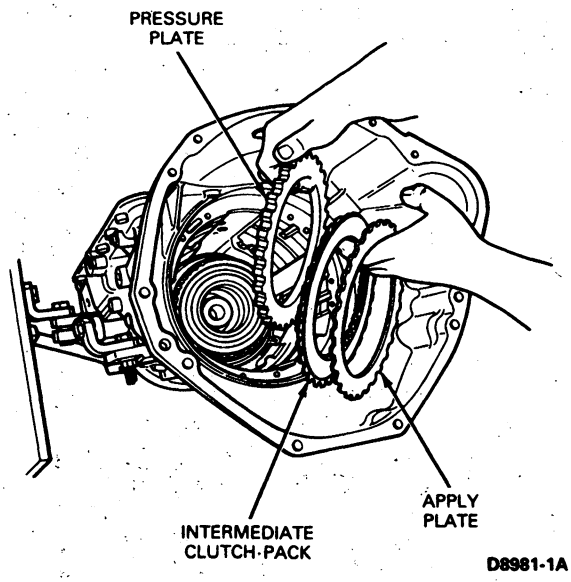
27. Remove center support.



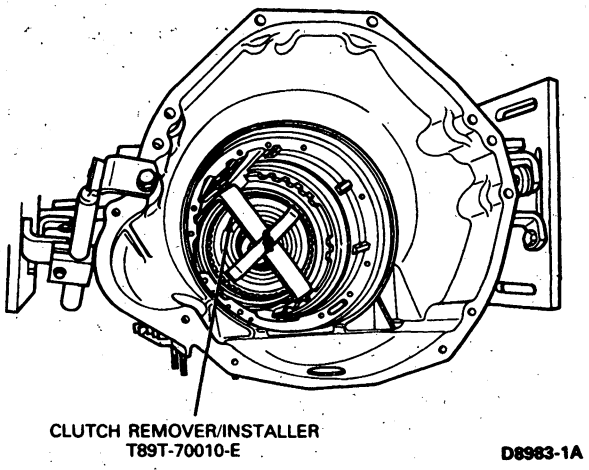
28. Remove thrust washer No. 7L326.



29. Remove intermediate pressure plate and clutch plates. Tag clutch plates for re-assembly.



30. Remove intermediate band.

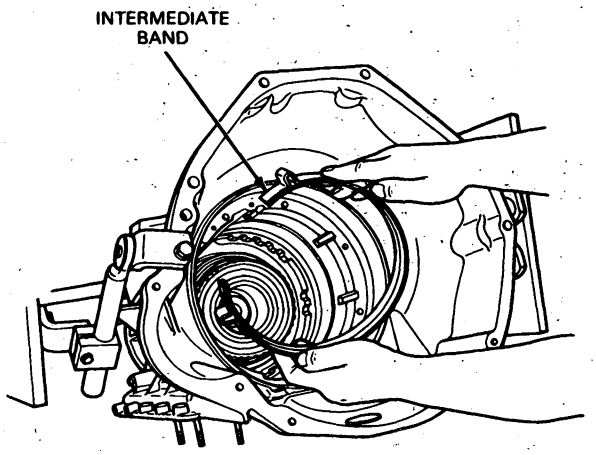


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DISASSEMBLY AND ASSEMBLY (Continued)

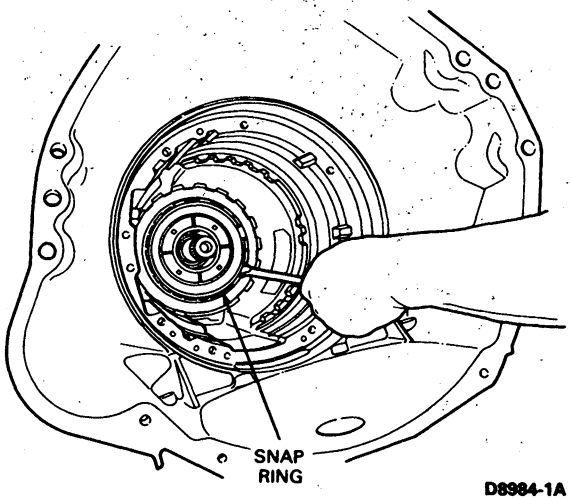
31. Remove direct clutch forward clutch and shell using Clutch Remover/Installer T89T-70010-E or equivalent.

NOTE: Hooks on crossbar must be rotated into notches on input shell. Refer to illustration.



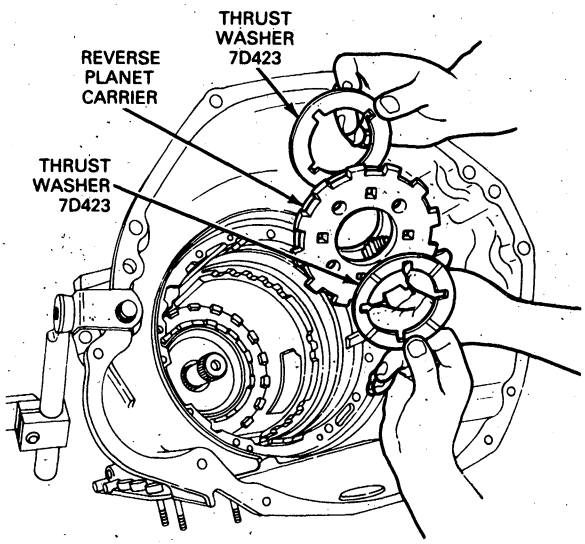
D8982-1A

32. Using large screwdriver, remove reverse snap ring.



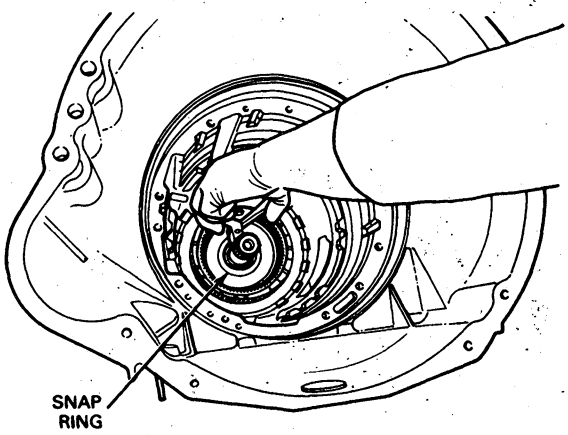
D8984-1A

33. Remove reverse planet carrier and two thrust washers No. 7D423.



D8985-1A

34. Using Snap Ring Pliers, remove the output shaft snap ring. Discard snap ring.

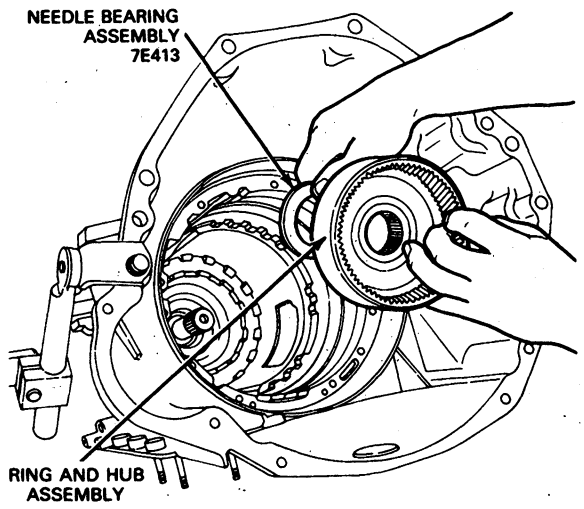


D8986-1A

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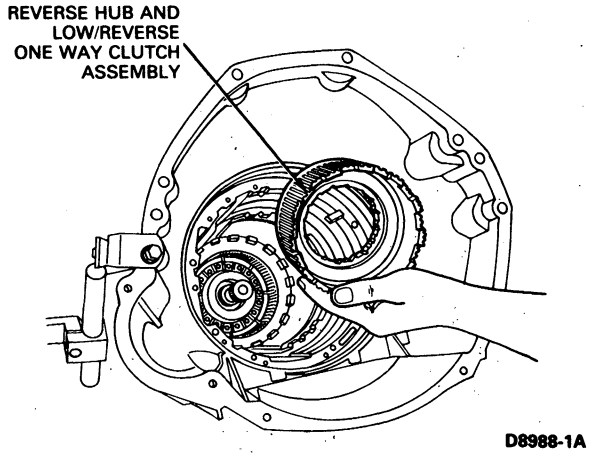
DISASSEMBLY AND ASSEMBLY (Continued)

35. Remove ring gear and hub assembly, and needle bearing assembly No. 7E413.



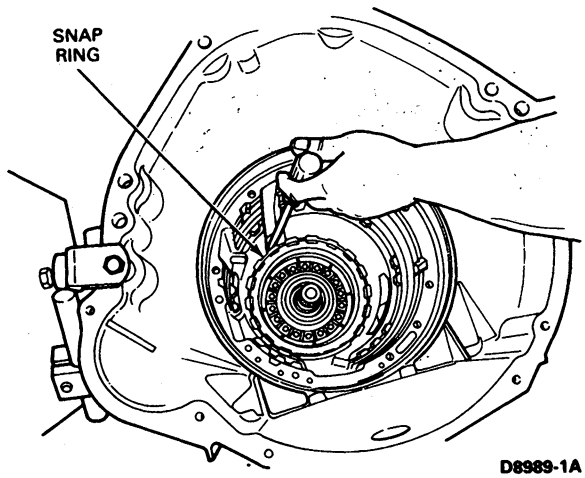
D8987-1A

36. Remove reverse hub and one-way clutch assembly.



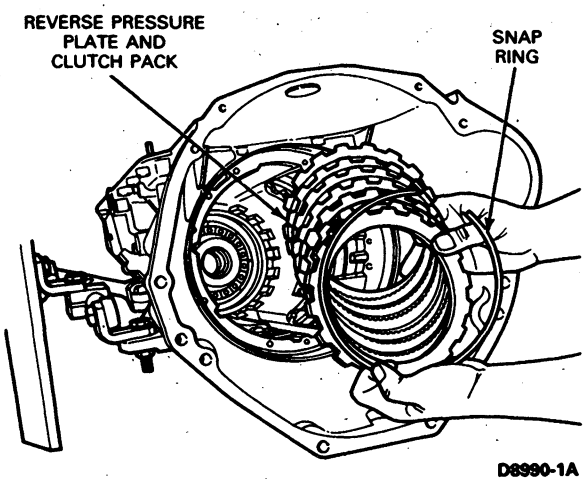
D8988-1A

37. Using a large screwdriver remove reverse clutch snap ring.



D8989-1A

38. Remove reverse pressure plate and clutch pack. Tag for re-assembly.

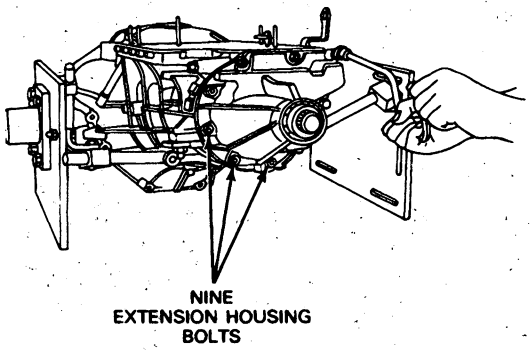


D8990-1A

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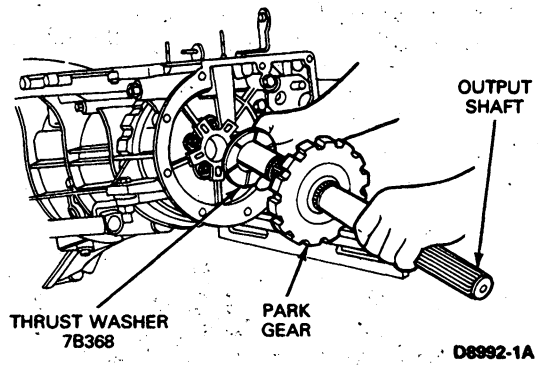
DISASSEMBLY AND ASSEMBLY (Continued)

39. Rotate transmission so that pan surface is facing up.
40. Remove nine extension housing bolts (13mm socket). Remove wiring bracket, extension housing and gasket, (discard gasket).



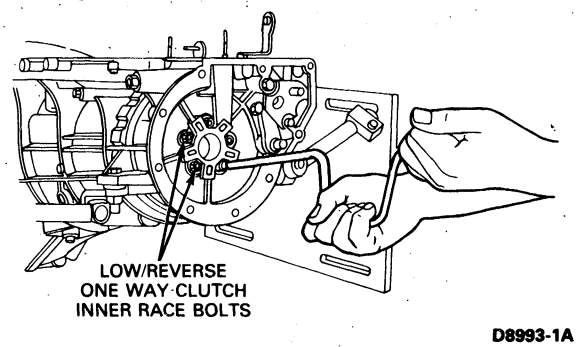
D8991-1A

41. Remove output shaft, park gear and thrust washer No. 7B368.



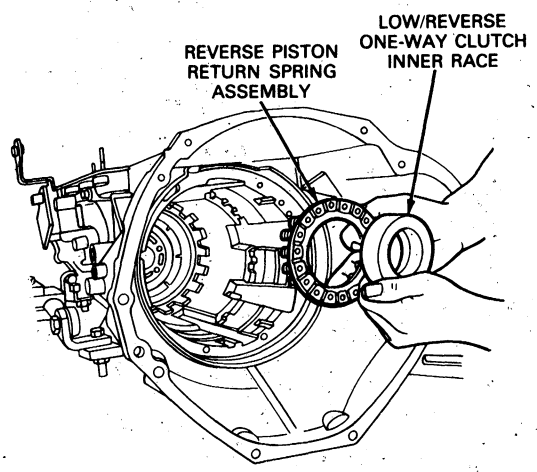
D8992-1A

42. Remove five bolts (11mm socket) from the low/reverse one-way clutch inner race.



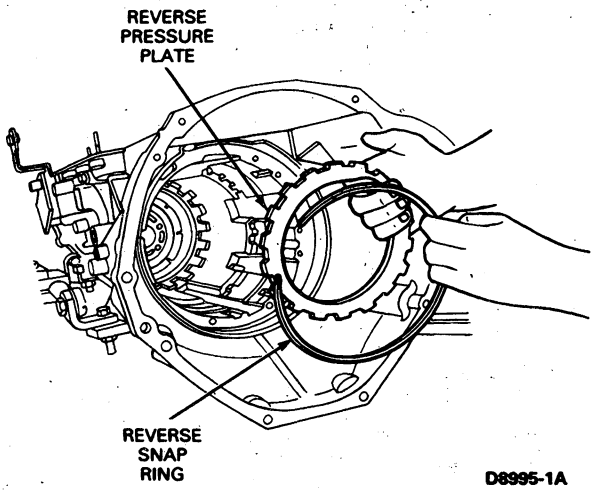
D8993-1A

43. Remove reverse clutch, return spring and inner race.



D8994-1A

44. **CAUTION: Install reverse clutch pressure plate and snap ring, to hold reverse clutch piston during removal.**

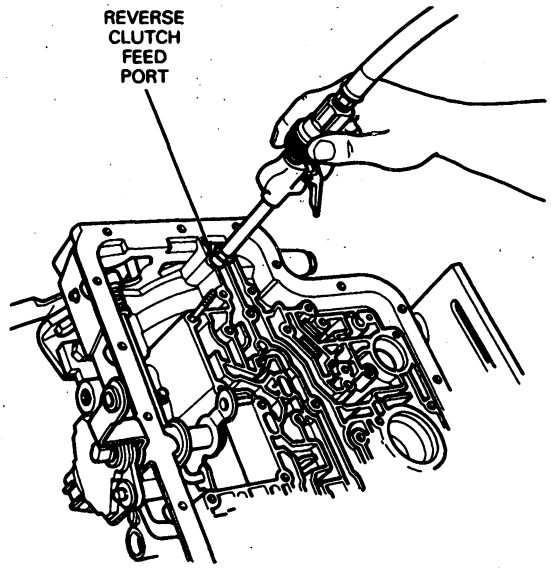


D8995-1A

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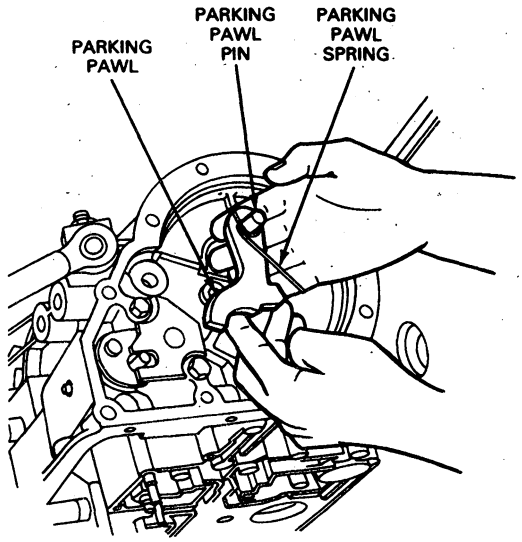
DISASSEMBLY AND ASSEMBLY (Continued)

45. Blow air into reverse clutch feed port using compressed air. This will blow out the reverse clutch piston against the pressure plate.



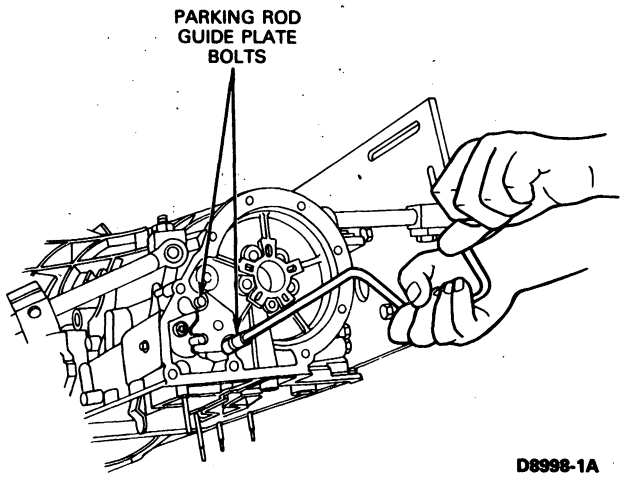
D8996-1A

46. Remove snap ring, reverse clutch pressure plate and piston from case.
47. Rotate transmission so that pan surface is facing down.
48. Remove park pawl return spring, pin and parking pawl from case.



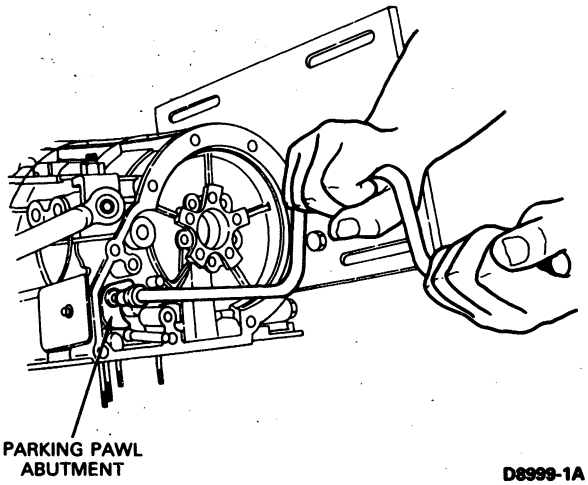
D8997-1A

49. Remove two bolts (13 mm socket) from parking rod guide plate.



D8998-1A

50. Remove the Torx® head bolt (40A bit) and parking pawl abutment.

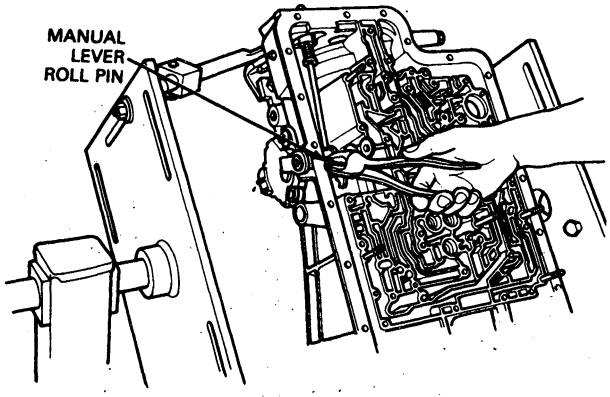


D8999-1A

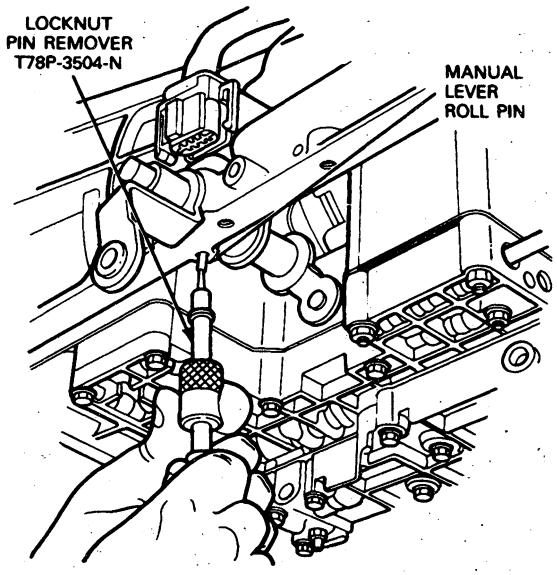
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DISASSEMBLY AND ASSEMBLY (Continued)

51. Using side cutters or Locknut Pin Remover T78P-3504-N or equivalent remove manual lever roll-pin from the case.

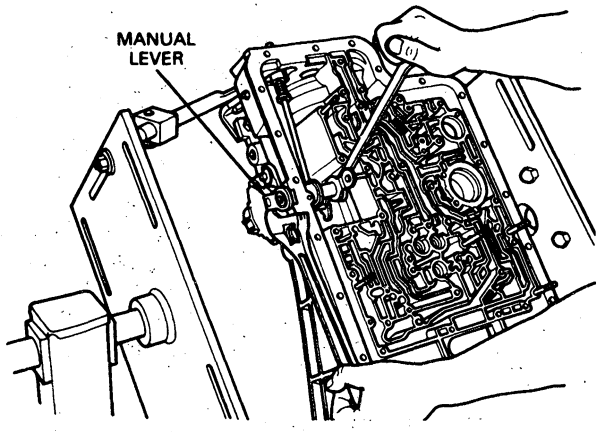


D9000-1A



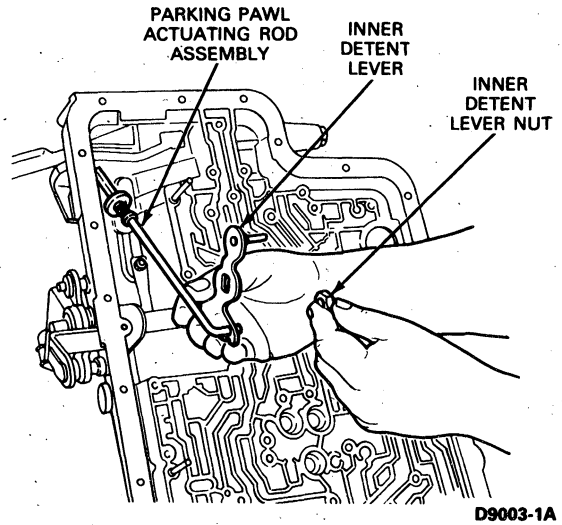
D9234-1A

52. Remove inner detent lever nut (21mm box wrench), while holding lever with crescent wrench.



D9002-1A

53. Remove inner detent lever and parking pawl actuating rod assembly from manual lever.

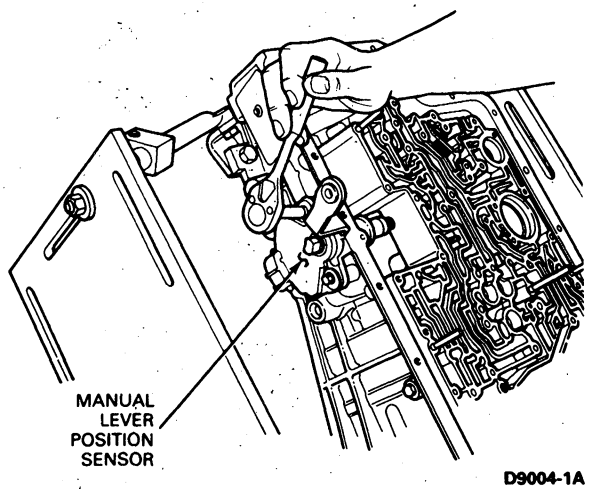


D9003-1A

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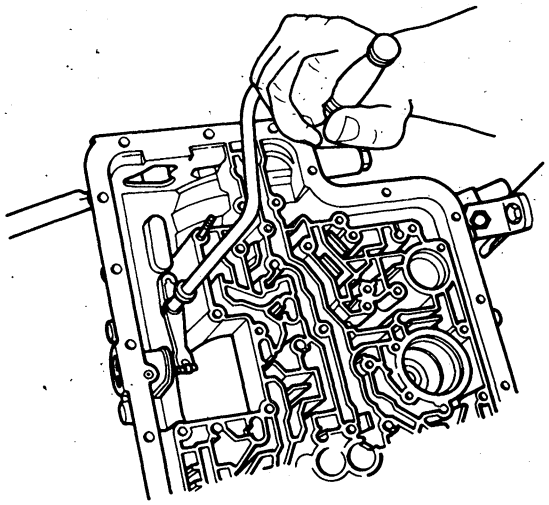
DISASSEMBLY AND ASSEMBLY (Continued)

54. Remove two bolts (8mm socket) and manual lever position sensor.



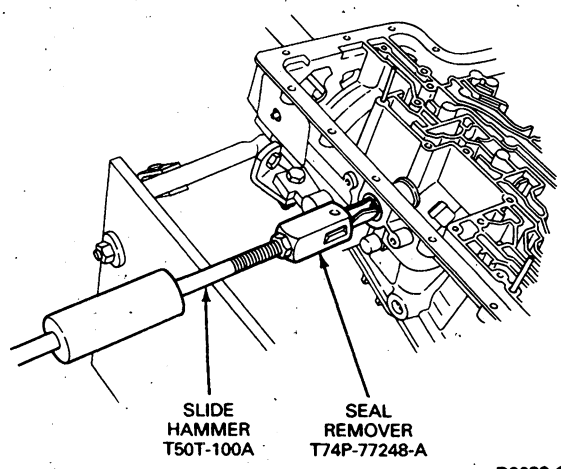
D9004-1A

55. Remove manual lever.



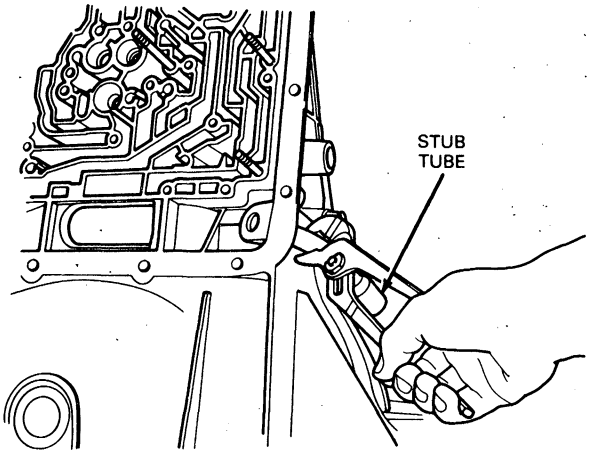
D9005-1A

56. Remove manual lever seal using Seal Remover T74P-77248-A and Slide Hammer T50T-100-A or equivalents.



D9028-1A

57. If required, remove stub tube, using channel lock pliers.



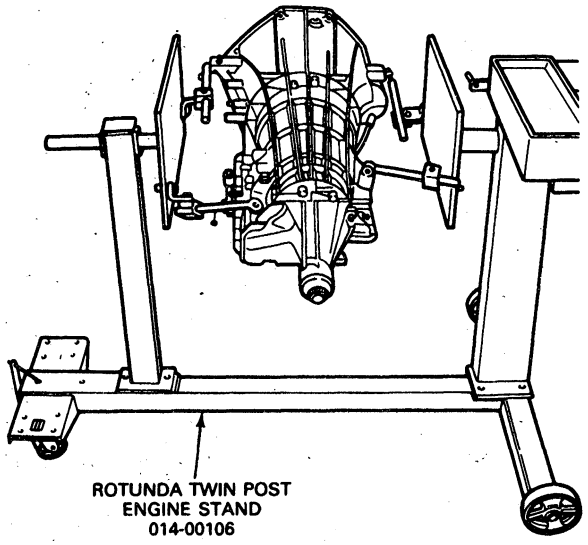
D9006-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

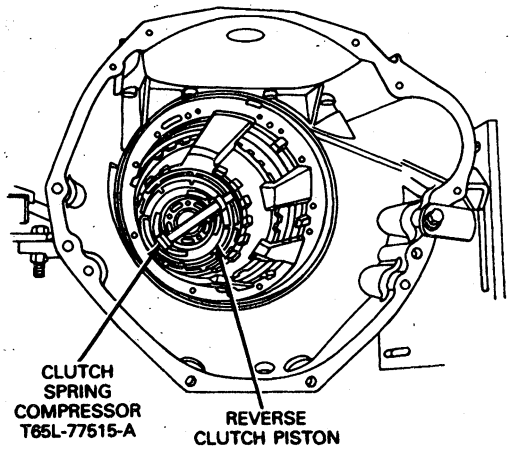
1. Soak all friction clutch plates in clean transmission fluid ESP-M2C166-H or equivalent for 15 minutes.
2. Lightly lubricate all O-ring seals before installing using transmission fluid ESP-M2C166-H or equivalent.
3. Lightly grease all thrust washers, to hold in place during assembly.
4. Mount transmission in Twin Post Engine Stand Rotunda 014-00106 or equivalent.



D8952-2A

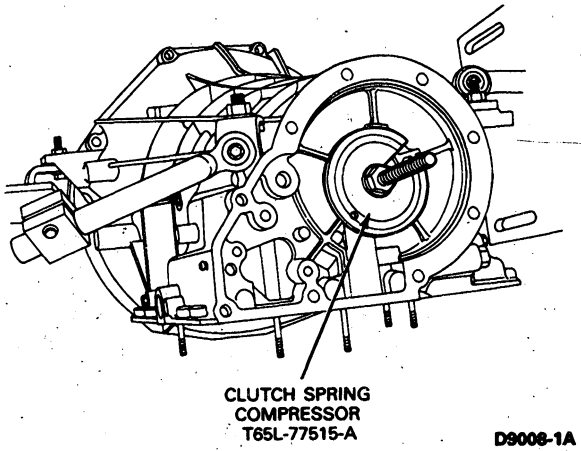
5. Rotate transmission so that bell housing is facing up.
6. Install inner and outer seals on the reverse clutch piston.
7. Install reverse clutch piston using Clutch Spring Compressor T65L-77515-A or equivalent. Remove tool after installing piston.

Front View



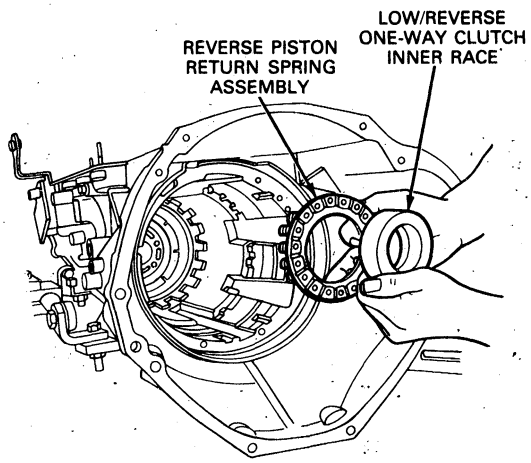
D9007-1A

Rear View



D9008-1A

8. Install reverse piston return spring assembly and one-way clutch inner race.

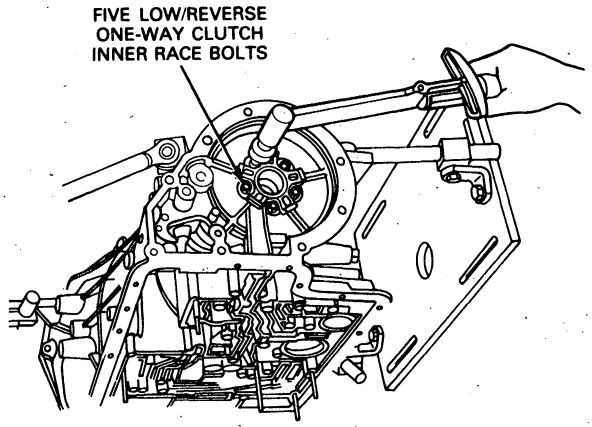


D8994-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

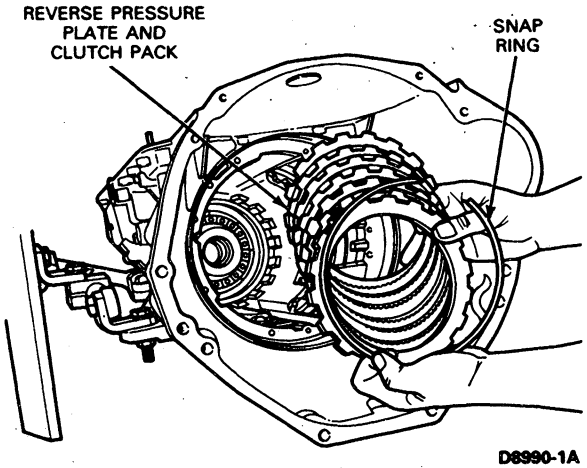
9. Attach to case with five bolts (11mm socket) and tighten to 25-33 N·m (18-25 ft-lb).



D9009-1A

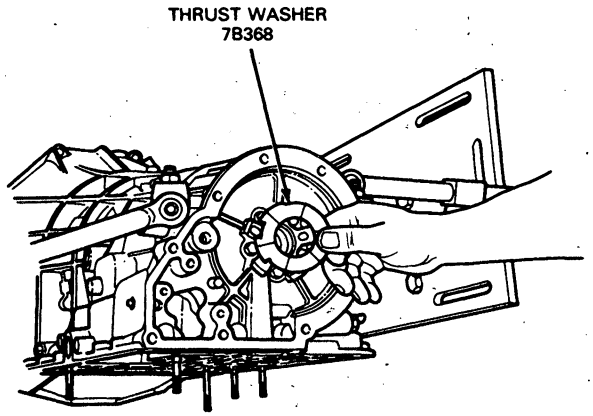
10. Install a six internal spline plate reverse clutch pack starting with an external spline plate. Alternate external spline plates with internal spline plates. Install snap ring.

NOTE: No stack-up clearance measurement required.



D8990-1A

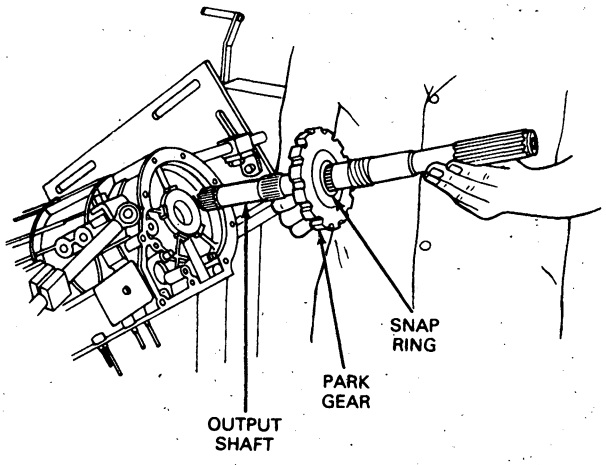
11. Rotate transmission to horizontal position.
12. Grease steel side of the thrust washer No. 7B368 and place on rear of case so that bronze side is facing outward.



D9010-1A

13. Install snap ring onto output shaft. Slide park gear onto shaft with thrust surface opposite snap ring. Install output shaft.

WARNING: DO NOT OVEREXTEND SNAP RING WHEN INSTALLING. ENSURE SNAP RING IS SECURELY SEATED IN GROOVE.

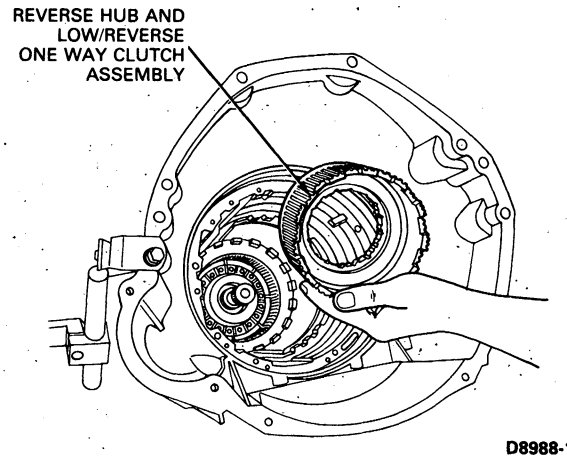


D9011-1A

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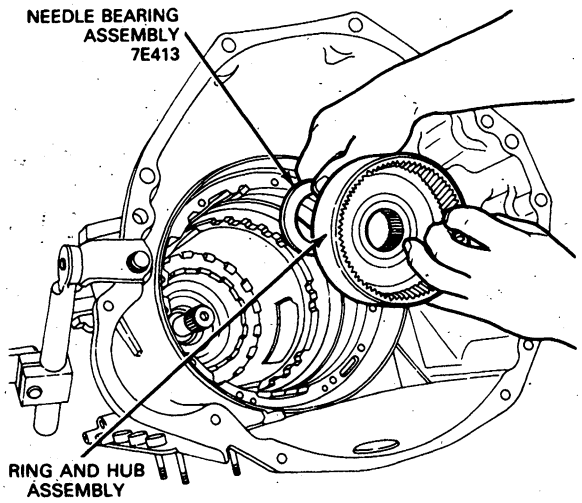
DISASSEMBLY AND ASSEMBLY (Continued)

14. Install reverse hub and low/reverse one way clutch.



D8988-1A

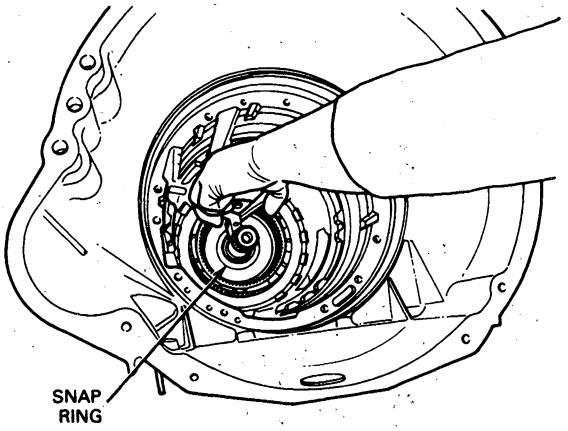
15. Install output shaft hub and reverse ring gear, placing needle needle bearing assembly No. 7E413 on rear surface of hub. Hold bearing in place with grease.



D8987-1A

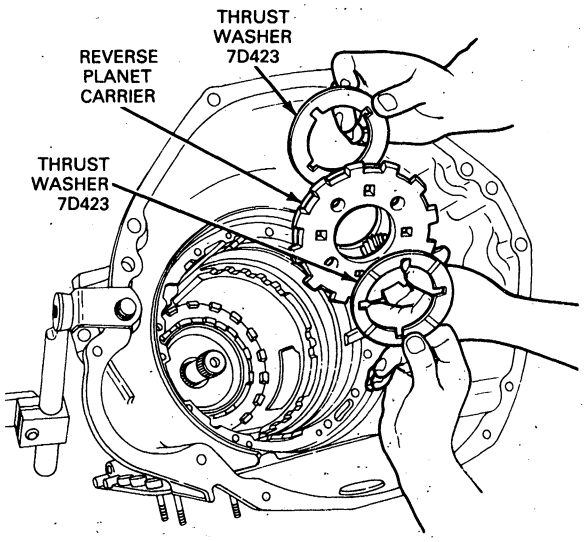
16. Install new snap ring onto output shaft.

WARNING: DO NOT OVEREXTEND SNAP RING WHEN INSTALLING. ENSURE SNAP RING IS SECURELY SEATED IN GROOVE.



D8986-1A

17. Install reverse plate carrier assembly into hub with thrust washer No. 7D423.

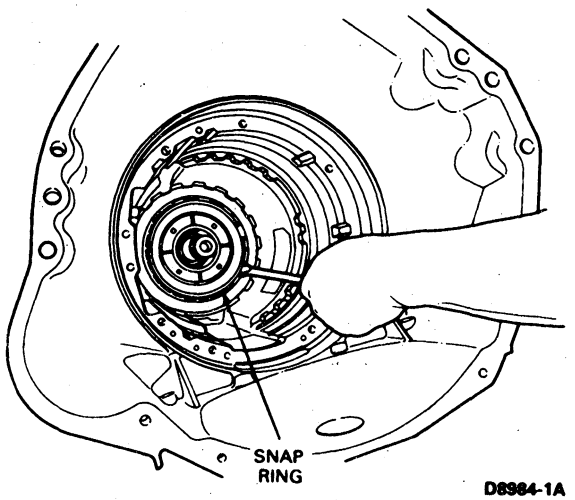


D8985-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

18. Install snap ring.

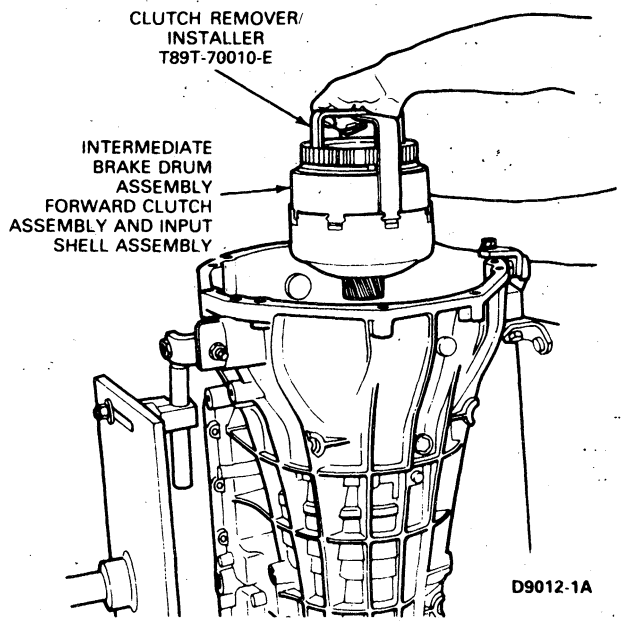


19. Rotate transmission so that bell housing is facing up.

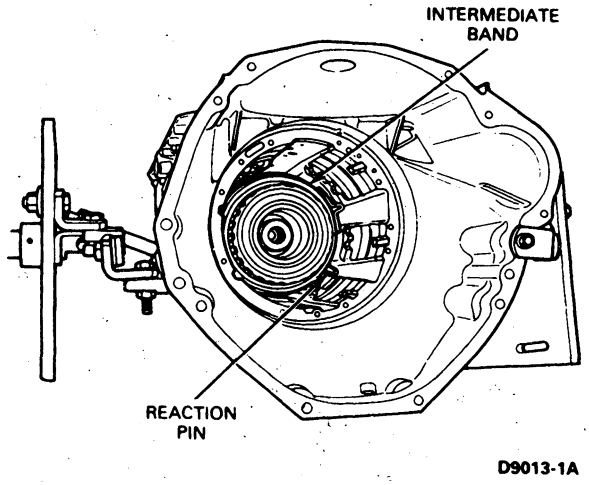
20. Attach Clutch Remover/Installer T89T-70010-E or equivalent, onto input shell and lower entire assembly (Intermediate Brake Drum Assembly, Forward Clutch Assembly and Input Shell Assembly) into case.

NOTE: It may be necessary to rotate output shaft to seat reverse sun gear.

Remove service tool.

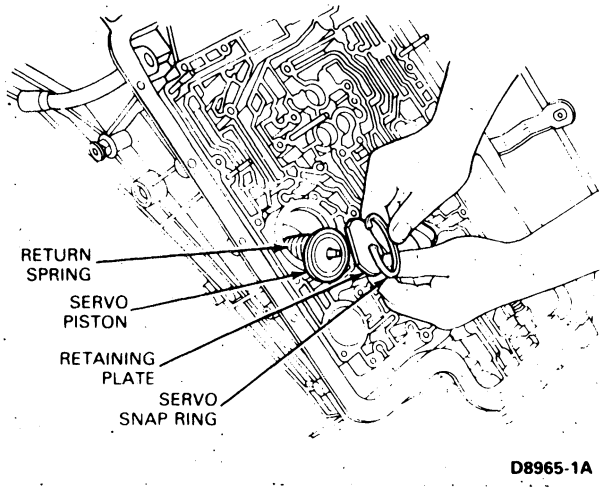


21. Install intermediate band so that one ear is resting on the reaction pin.



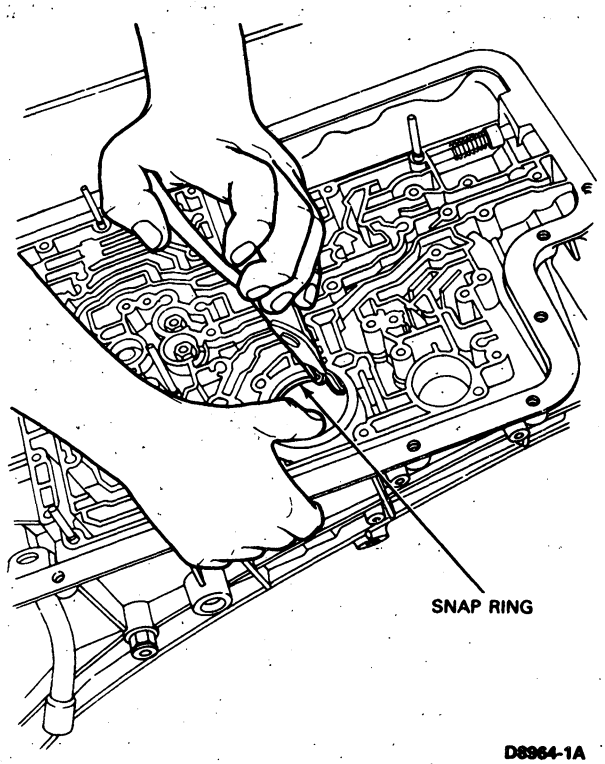
22. Install servo snap ring, retaining plate, piston and rod assembly and servo spring.

NOTE: Apply slight downward pressure to plate while removing snap ring.



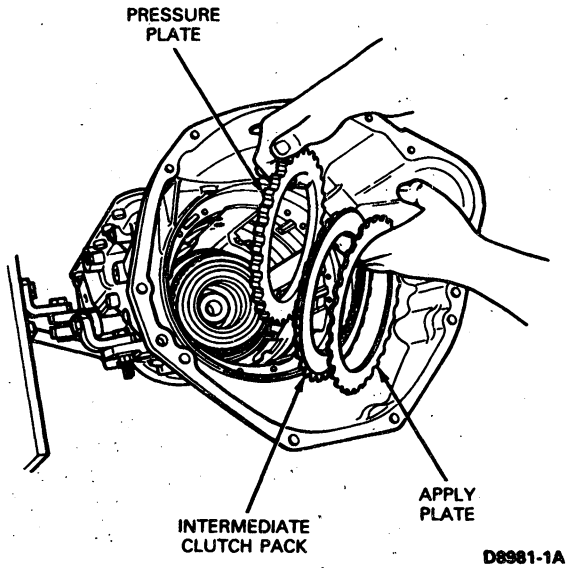
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DISASSEMBLY AND ASSEMBLY (Continued)



D8964-1A

23. Install intermediate pressure plate. Install clutch pack starting with internal spline plate. Install apply plate.



D8981-1A

24. Determine end play with following procedure:

The transmission rear end play check determines:

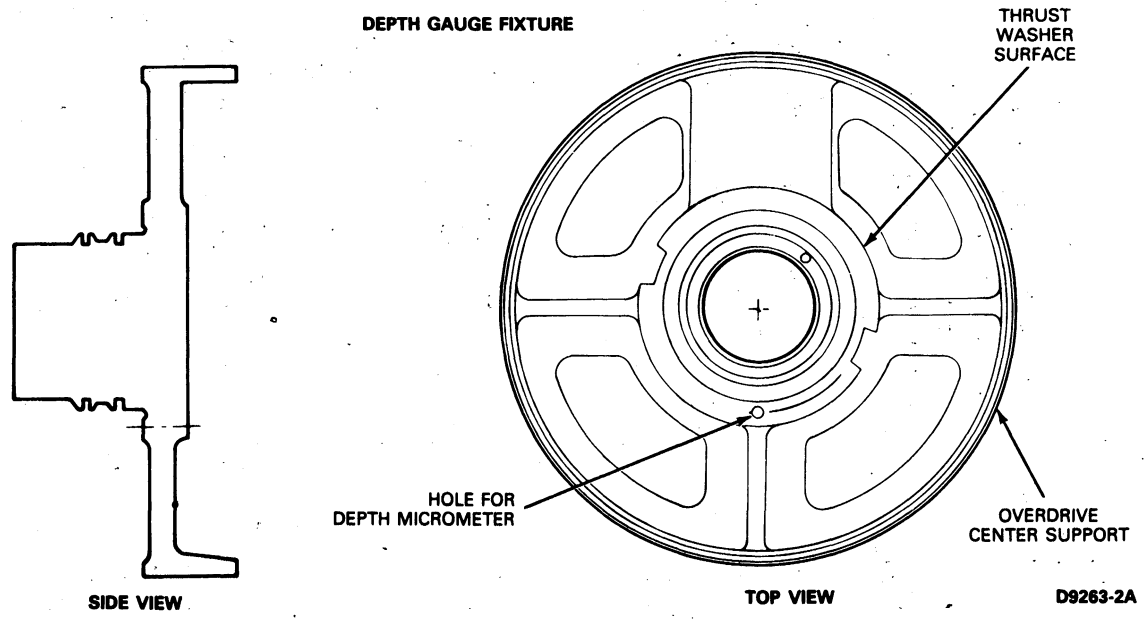
- The amount of space existing between the thrust washer surfaces of the center support and the intermediate brake drum. (2.06-.81mm) (.081-.032 inch)

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DISASSEMBLY AND ASSEMBLY (Continued)

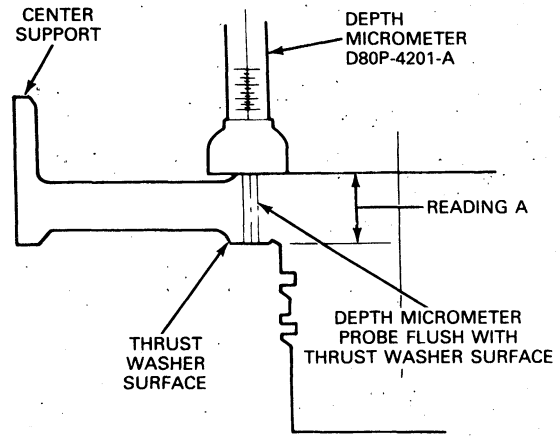
Step I

Use Depth Micrometer D80P-4201-A or equivalent to access the area between the thrust surfaces of the support and the intermediate brake drum. Remove the cast iron seals from the center support to allow easy insertion into the intermediate brake drum.



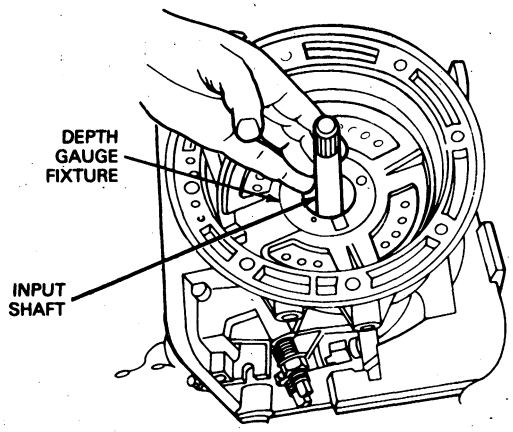
Step II

Place Depth Micrometer D80P-4201-A or equivalent over drilled hole in center support fixture. Extend micrometer probe until it is flush with thrust washer surface. Record micrometer reading. This is Reading A.



Step III

Install center support into intermediate brake drum and gently "wiggle" input shaft to allow center support fixture to slide into intermediate brake drum using its own weight. Ensure it is fully seated in transmission case.

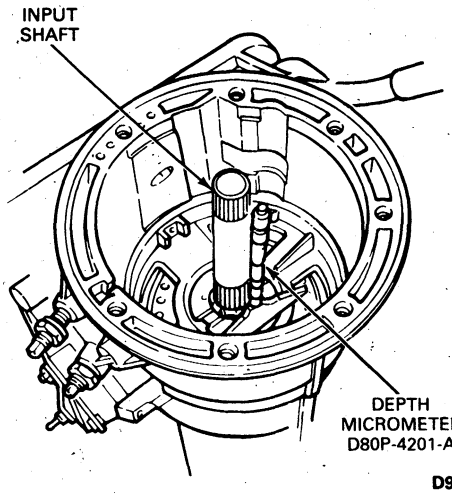


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DISASSEMBLY AND ASSEMBLY (Continued)

Step IV

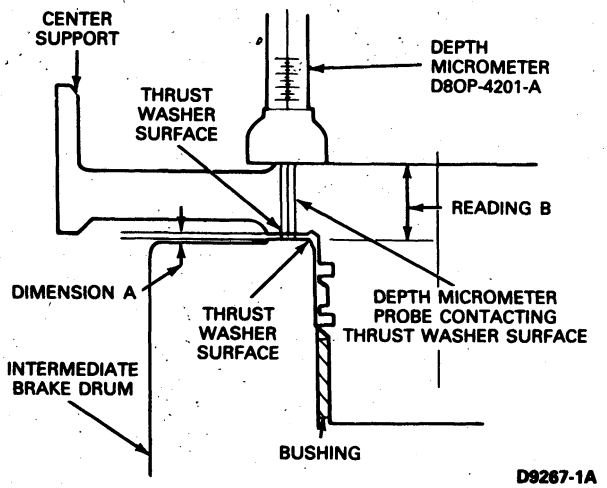
Place depth micrometer over drilled hole in center support.



D9266-1A

Step V

Continue extending micrometer probe until it contacts thrust washer surface of intermediate brake drum. This is Reading B.



D9267-1A

Step VI

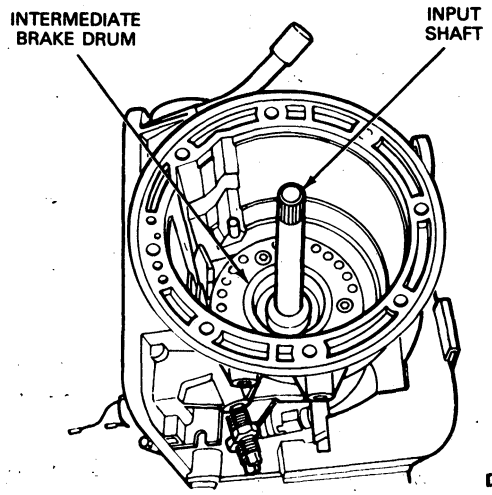
Subtract Reading A from Reading B. The difference between these readings is Dimension A. This is the space between thrust surfaces.

Subtract thrust washer thickness from Dimension A to determine final end play. Specification is 2.06-.81mm (.081-.032 in)

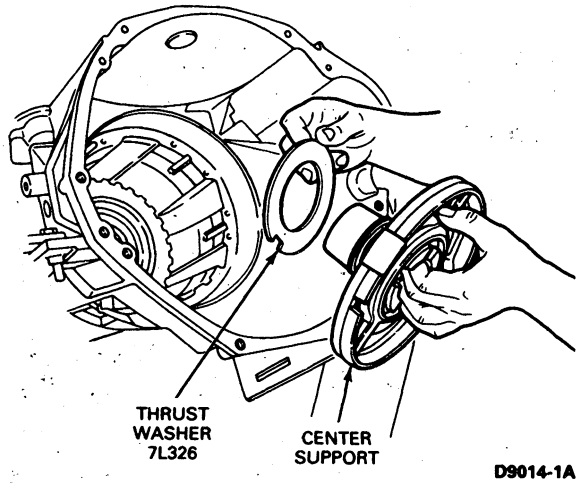
If final dimension is outside specified limits, this indicates improper assembly, missing parts or parts out of specification. This requires rebuilding the unit.

Step VII

Remove center support from intermediate brake drum. Position washer 7L326 on rear of center support using grease.



D9268-1A

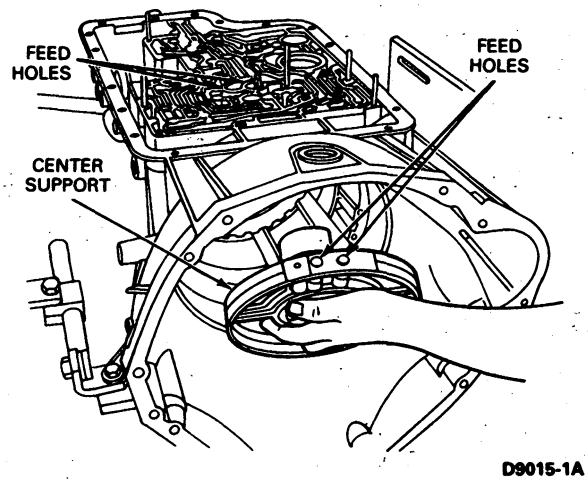


D9014-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

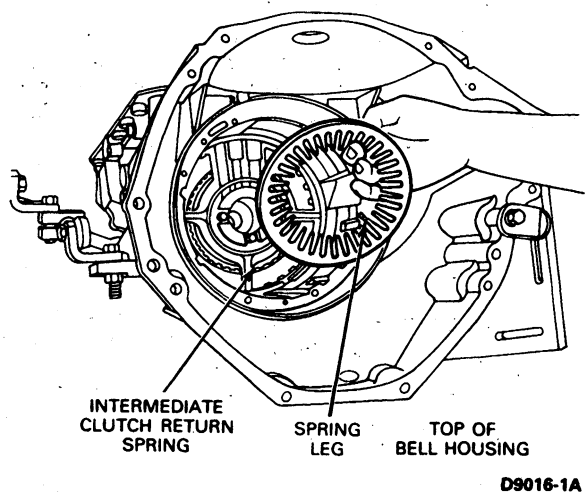
25. Install center support, align with holes in feed port. Install the two feed bolts. Do **not** tighten at this time.



26. Install intermediate clutch return spring with dished surface inward.

NOTE: Locate one spring leg pointing to the top of the transmission as illustrated.

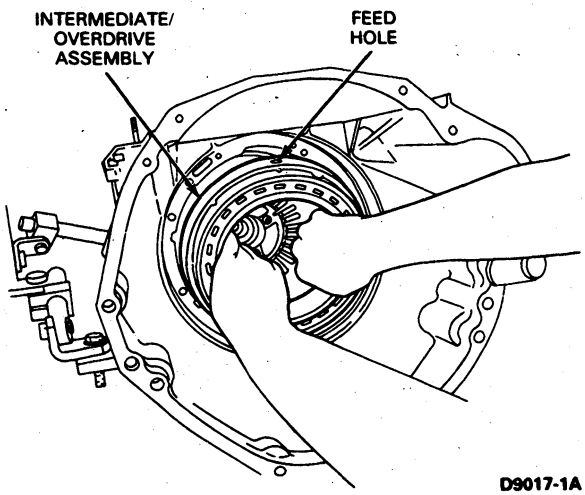
NOTE: Intermediate clutch return spring locator legs must be properly located inside of center support circular cast rib.



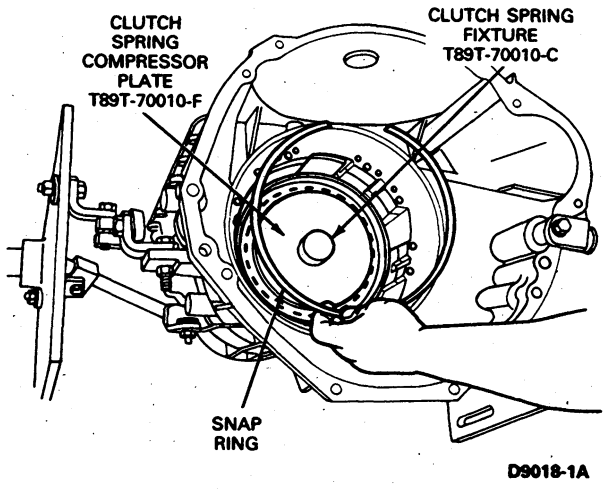
27. Install intermediate/overdrive cylinder assembly into case.

NOTE: Align cylinder assembly locator tab with center support and feel hole with hole in case. Install one feed bolt but do not tighten it.

CAUTION: Do not cock cylinder when installing.



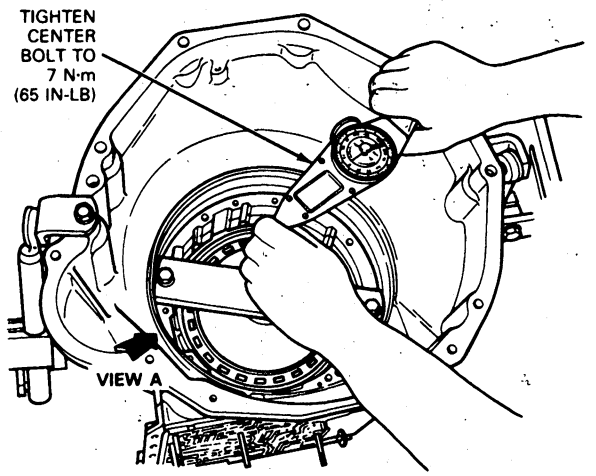
28. Install trial selective snap ring over intermediate clutch cylinder assembly so that ring opening is at bottom of case for proper oil drainback. Place Clutch Spring Compressor Plate T89T-70010-F and Intermediate Clutch Spring Fixture T89T-70010-C or equivalents onto intermediate clutch cylinder assembly.

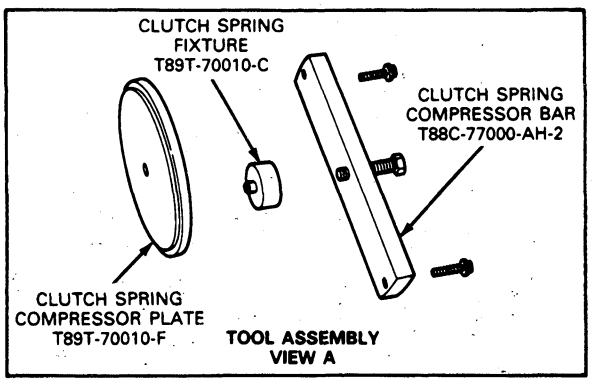


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DISASSEMBLY AND ASSEMBLY (Continued)

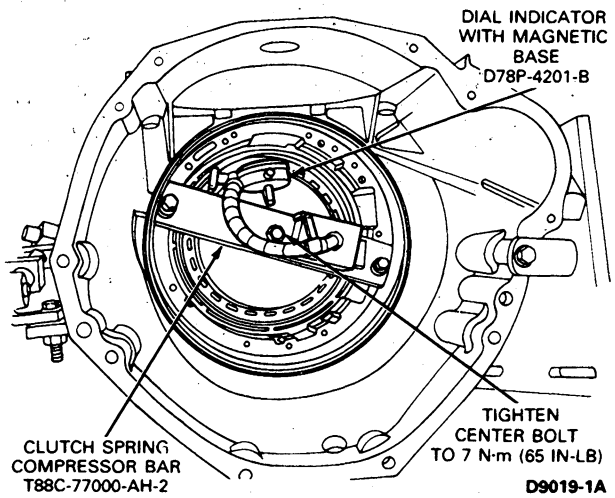
29. Tighten center bolt to 7 N·m (65 in-lb). Seat selective snap ring into case ring groove.





D8975-1A

30. Attach Dial Indicator with Magnetic Base D78P-4201-B or equivalent to bar. Place stylus onto Compressor Plate T89T-70010-F or equivalent and zero dial.



D9019-1A

31. Release torque on center bolt and note reading on indicator. If reading is not within specifications, repeat procedure using the correct selective snap ring.

Specifications:

1.37 - 0.67mm (0.054 - 0.026 inch)

Selective Snap Rings:

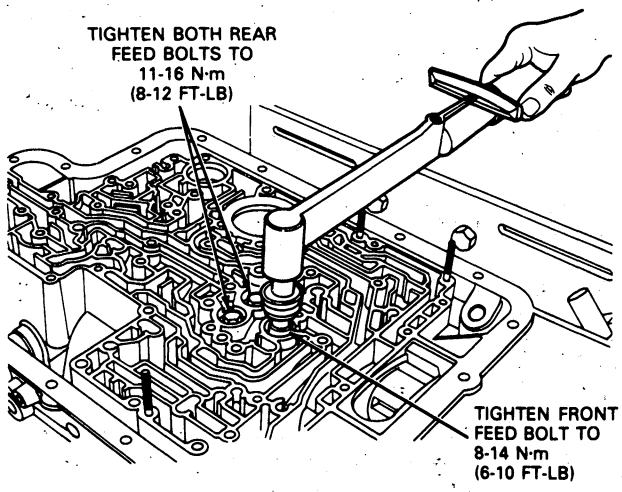
1.55 - 1.45mm (0.061 - 0.057 inch)

2.05 - 1.95mm (0.080 - 0.076 inch)

2.60 - 2.50mm (0.100 - 0.098 inch)

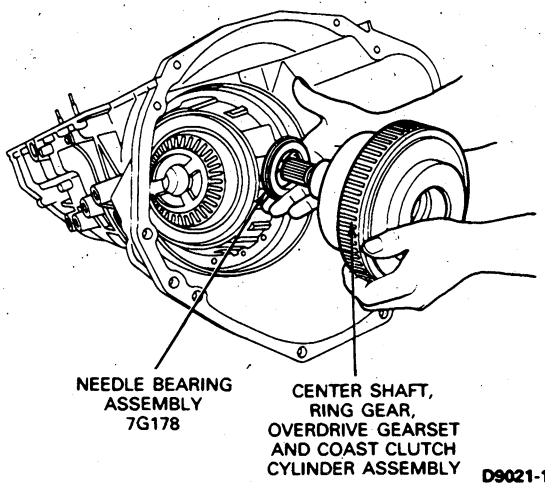
32. Remove Clutch Spring Tool Assembly. Tighten three feed bolts (13mm socket) into intermediate/overdrive cylinder assembly and center support.

CAUTION: Tighten the front feed bolt to 9-13 N·m (6-10 ft-lbs). Tighten both rear feed bolts to 11-16 N·m (8-12 ft-lbs).



D9020-1A

33. Using grease, place needle bearing assembly No. 7G178 on rear face of center shaft. Install center shaft, overdrive ring gear, overdrive planetary gearset and coast clutch cylinder as an assembly.

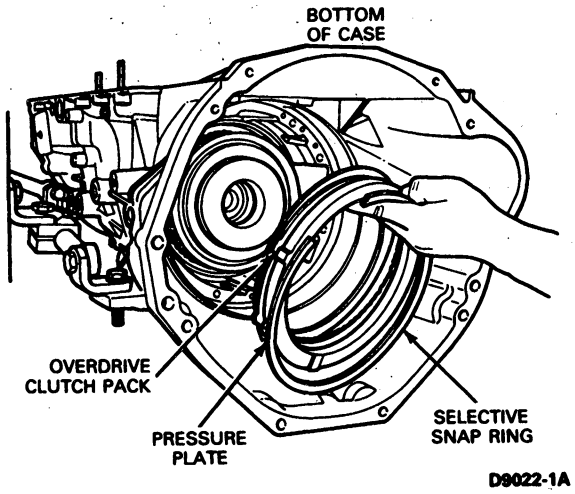


D9021-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

34. Install overdrive clutch pack starting with steel plate. Install pressure plate with dot facing outward and toward the top of the transmission. Install trial selective snap ring with opening at bottom of case.



D9022-1A

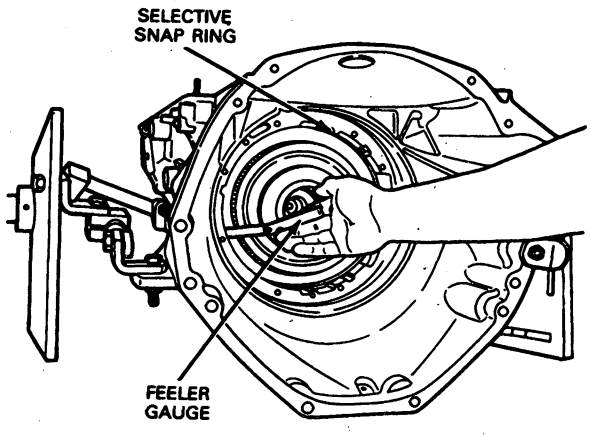
35. Check stack-up clearance using a feeler gauge. If not within specification, install correct selective snap ring and recheck.

Specification:

1.20 - 0.55mm (0.047 - 0.022 inch)

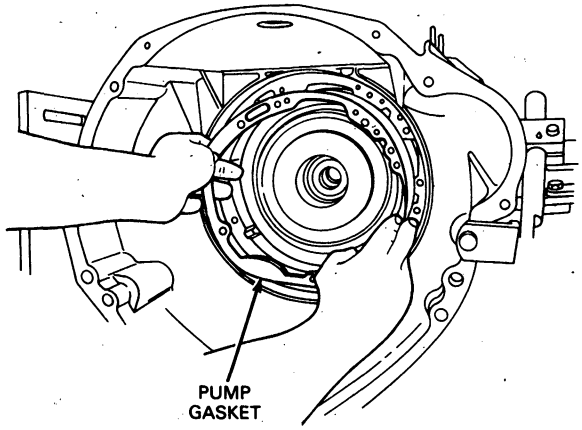
Selective Snap Rings

1.55 - 1.45mm (0.061 - 0.057 inch)
2.05 - 1.95mm (0.80 - 0.076 inch)
2.60 - 2.50mm (0.10 - 0.098 inch)
3.10 - 3.00mm (0.12 - 0.118 inch)
3.60 - 3.50mm (0.14 - 0.137 inch)



D9023-1A

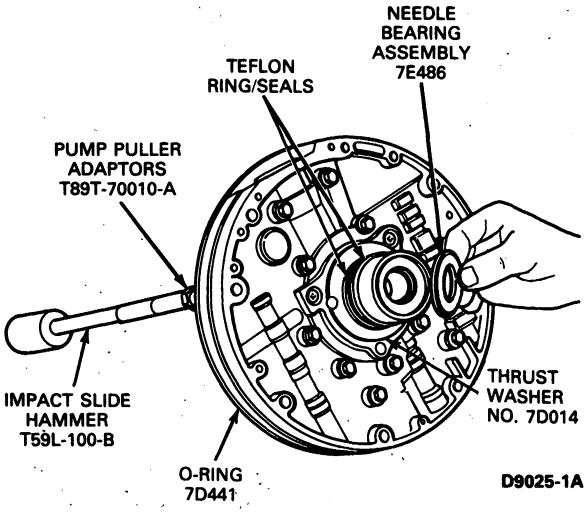
36. Install pump gasket into case.



D9024-1A

37. Screw Pump Puller Adapters T89T-70010-A or equivalent into pump threaded holes. Screw on Impact Slide Hammers T59L-100-B or equivalent.

38. Install thrust washer No. 7D014 and needle bearing assembly 7E486 onto pump. Use grease to hold in place.

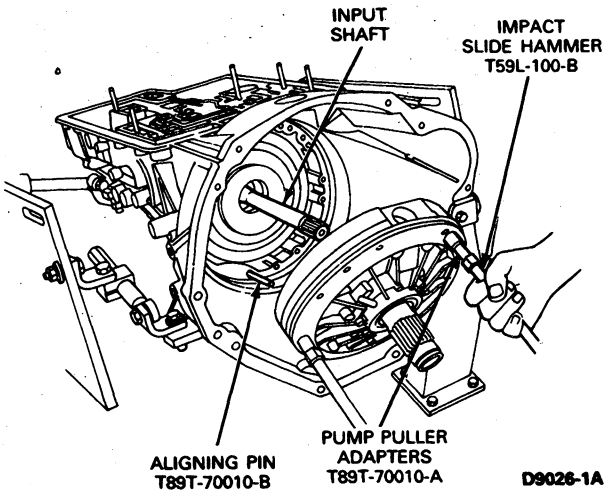


D9025-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

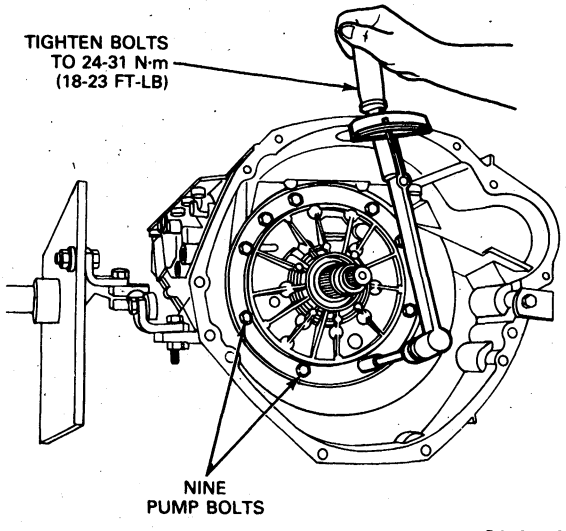
39. Install input shaft (long splined end first) and Alignment Pin T89T-70010-B or equivalent into the case as shown. Install the pump into the case. Orient the filter inlet tube bore towards the valve body mounting surfaces.



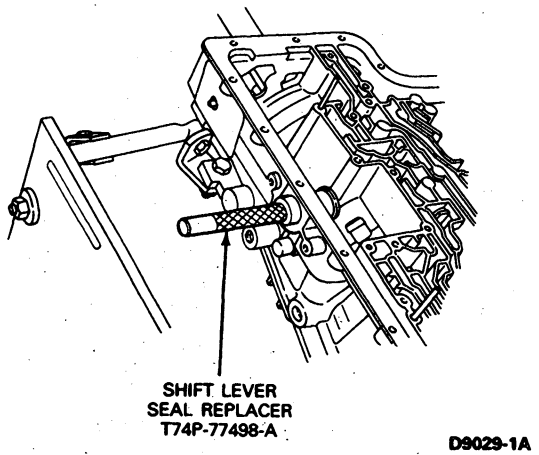
40. Remove old rubber coated washers from the nine pump to case bolts. Install new pump bolt washers. Remove Aligning Pin T89T-70010-B. Install pump using nine bolts (10mm socket). Tighten to 24-31 N·m (18-23 ft-lb).

NOTE: Draw pump into case evenly to avoid seal damage.

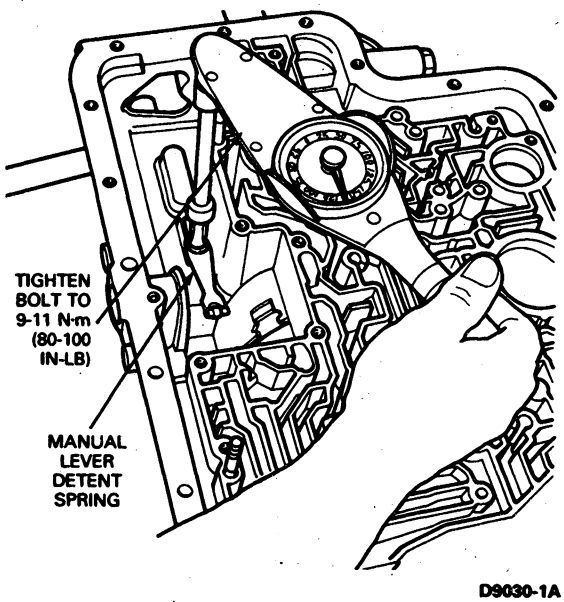
CAUTION: Remove input shaft.



41. Install manual lever seal using Shift Lever Seal Replacer T74P-77498-A or equivalent.



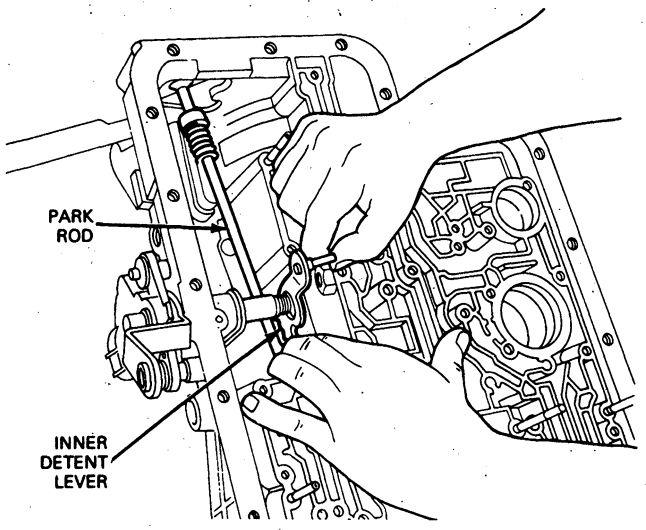
42. Install manual lever detent spring bolt (8mm socket). Tighten to 9-11 N·m (80-100 in-lb).



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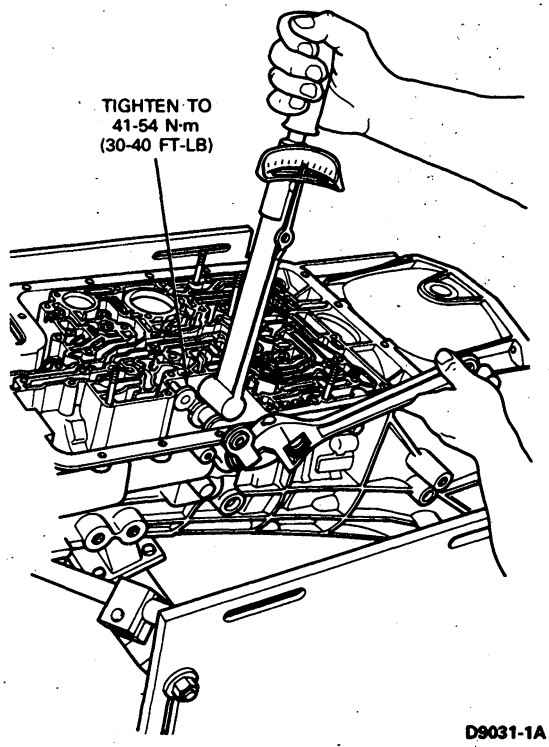
DISASSEMBLY AND ASSEMBLY (Continued)

43. Install manual lever, inner lever, park actuating rod assembly and nut (21mm box wrench).



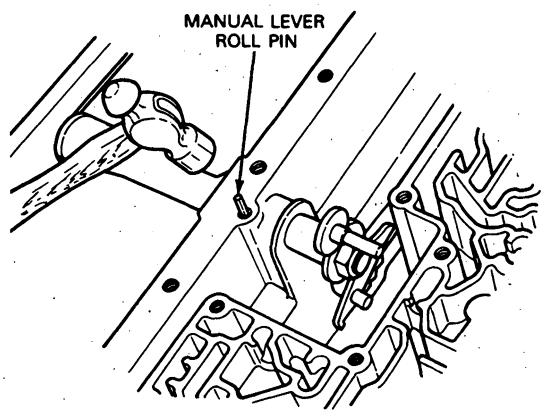
D7876-1A

44. Tighten manual lever nut (13/16 crows foot) to 41-54 N·m (30-40 ft-lbs).



D9031-1A

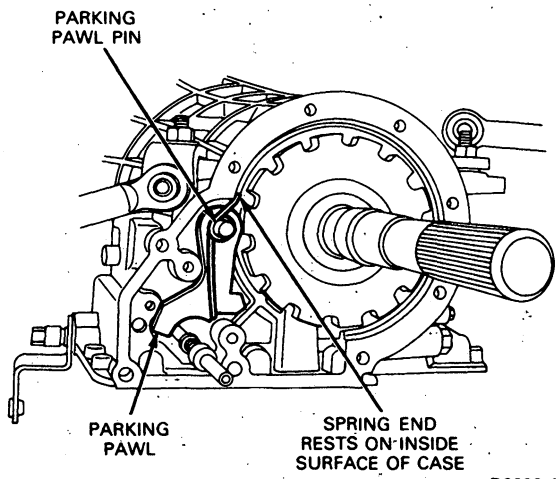
45. Install manual lever roll so that pin is just below case surface.



D9032-1A

46. Install parking pawl, pin and parking pawl return spring on rear face.

NOTE: Parking pawl return spring end rests on inside surface of case.

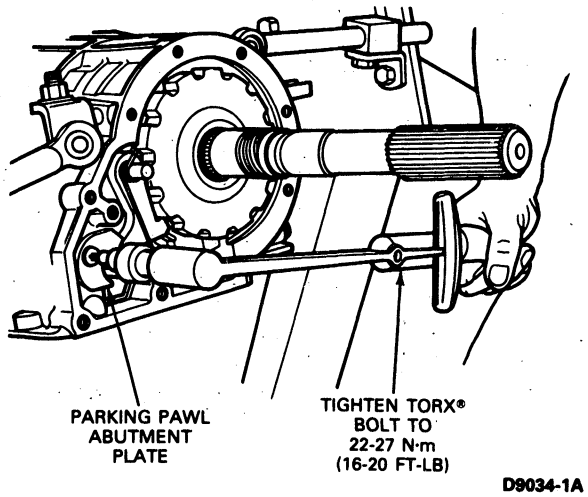


D9033-1A

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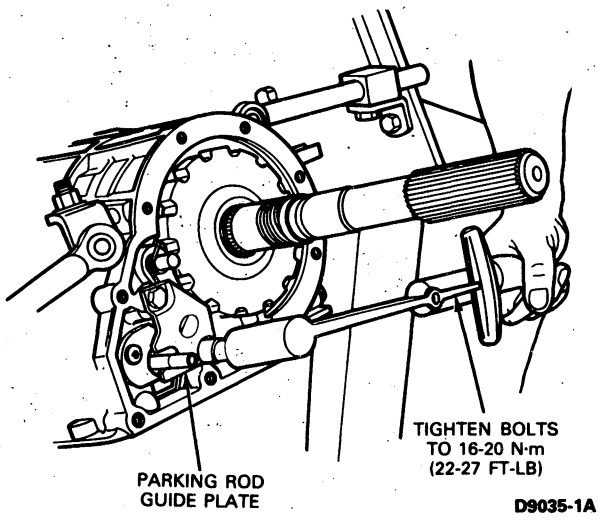
DISASSEMBLY AND ASSEMBLY (Continued)

47. Install parking pawl abutment with Torx® head bolt (40A bit) and tighten to 22-27 N·m (16-20 ft. lbs).

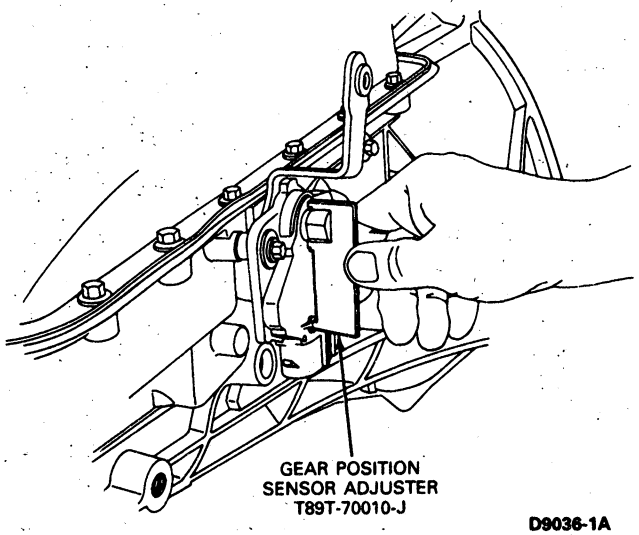


48. Attach parking rod guide plate with two bolts (13mm socket) and washers. Tighten to 22-27 N·m (16-20 ft9. lbs.).

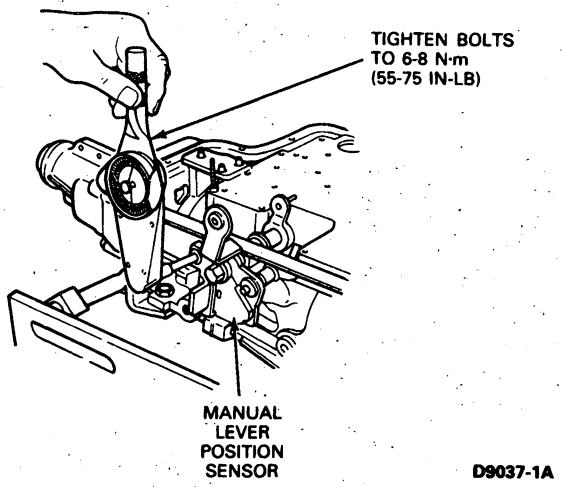
NOTE: Ensure plate dimple is facing inward.



49. Install manual lever position sensor with two bolts (8mm socket) and washers. Do not tighten bolts at this time. Align manual lever position sensor for neutral gear position using Gear Position Sensor Adjuster T89T-70010-J or equivalent.



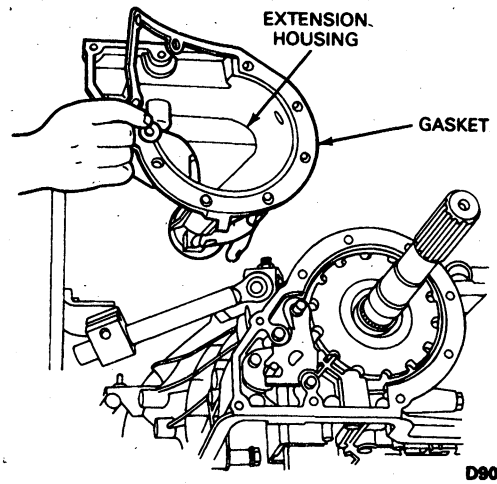
50. Tighten bolts (8mm socket) and washer to 6-8 N·m (55-75 in. lb.).



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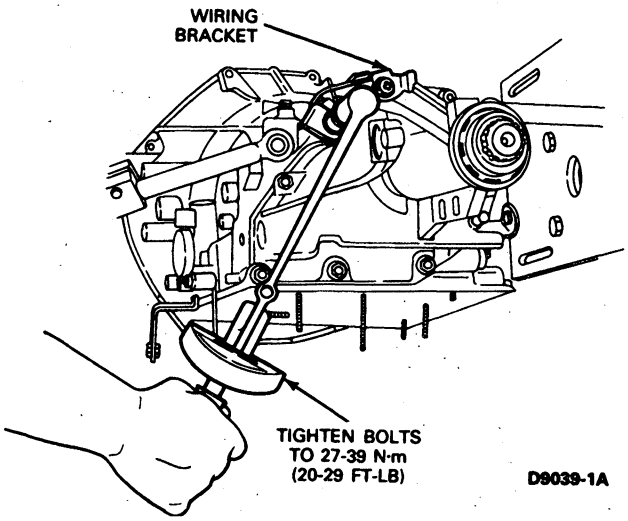
DISASSEMBLY AND ASSEMBLY (Continued)

51. Place gasket on extension housing.



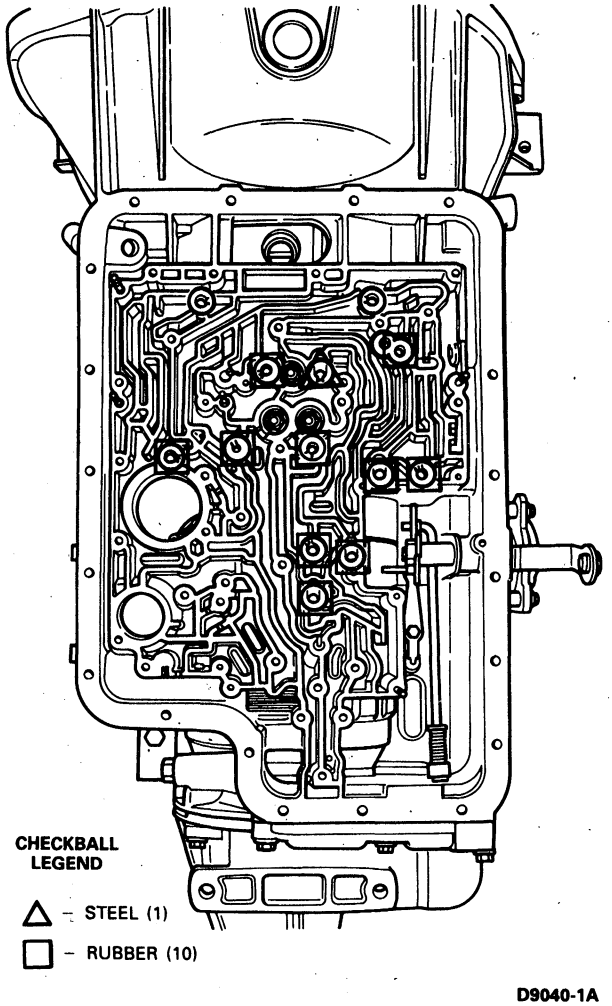
52. Install extension housing and wiring bracket on rear of case using nine bolts (13mm socket). Tighten bolts to 27-39 N·m (20-29 ft-lb).

NOTE: The two bottom bolts are longer on 4x4 vehicles.



53. Rotate transmission so that pan surface is facing up. Install one steel and ten rubber check balls, EPC blow-off spring and ball into case pockets.

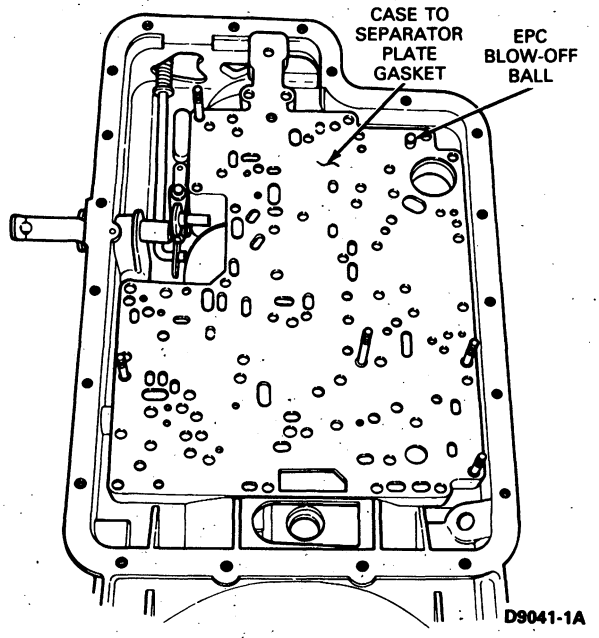
NOTE: Refer to illustration.



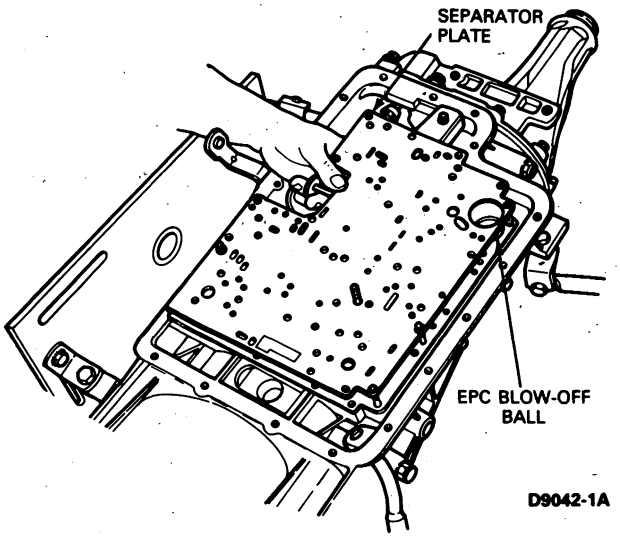
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DISASSEMBLY AND ASSEMBLY (Continued)

54. Install case-to-separator plate gasket.

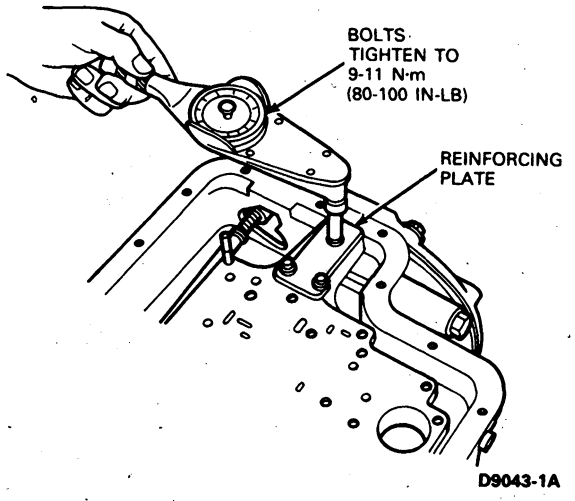


55. Install separator plate.

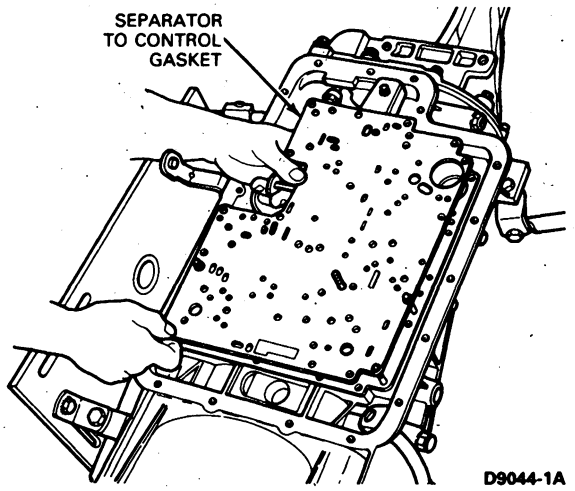


56. Attach reinforcing plate with three bolts (8mm socket) with stamped "up" facing up. Tighten to 9-11 N·m (80-100 in-lb).

NOTE: Check placement of EPC blow-off ball.



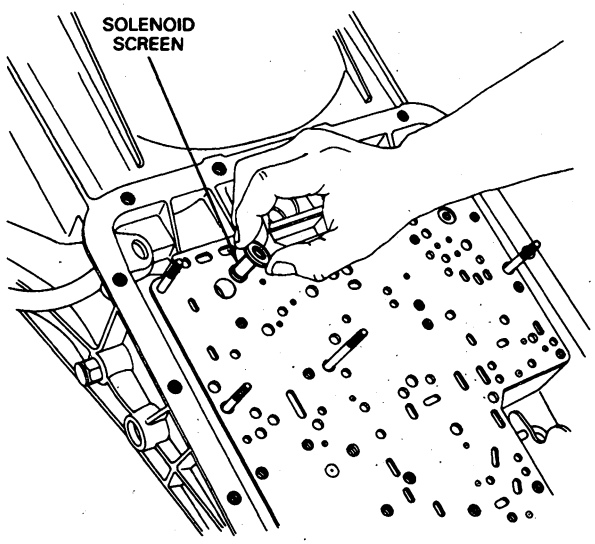
57. Install new separator-to-control gasket.



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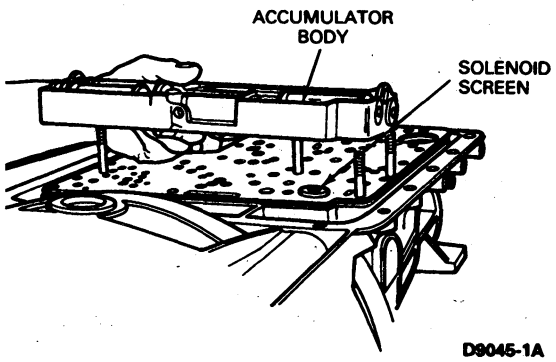
DISASSEMBLY AND ASSEMBLY (Continued)

58. Install solenoid screen into separator plate. Turn and lock solenoid screen.

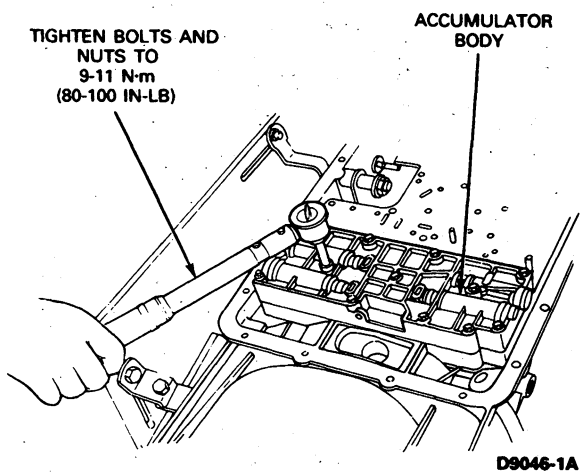


D8960-1A

59. Install accumulator body over studs and attach with two nuts (10mm socket) and 11 bolts (8mm socket). Tighten to 9-11 N·m (80-100 in-lb).

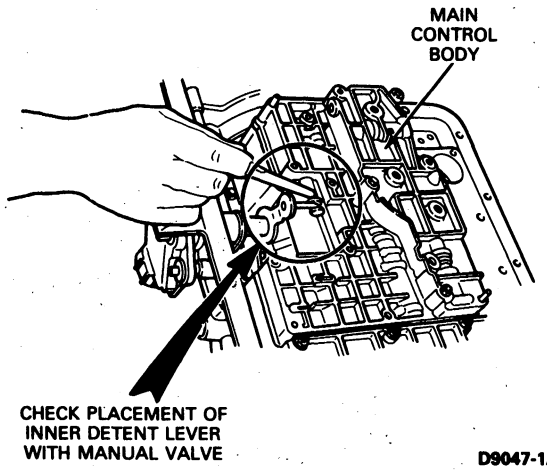


D9045-1A



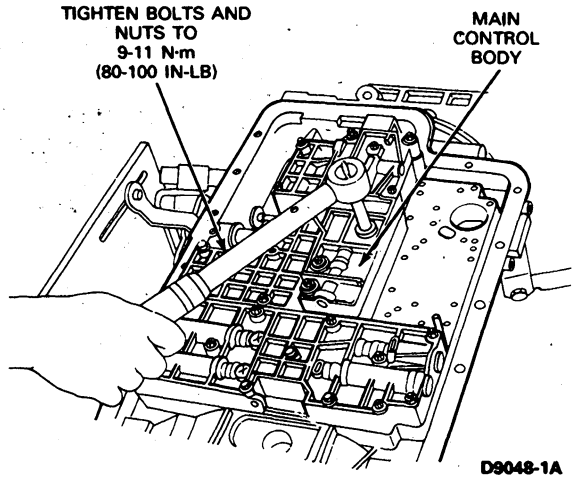
D9046-1A

60. Lower main control body over studs. Align manual valve with manual lever.



D9047-1A

61. Attach valve body with two nuts (10mm socket) and 14 bolts (8mm socket). Tighten to 9-11 N·m (80-100 in-lb).



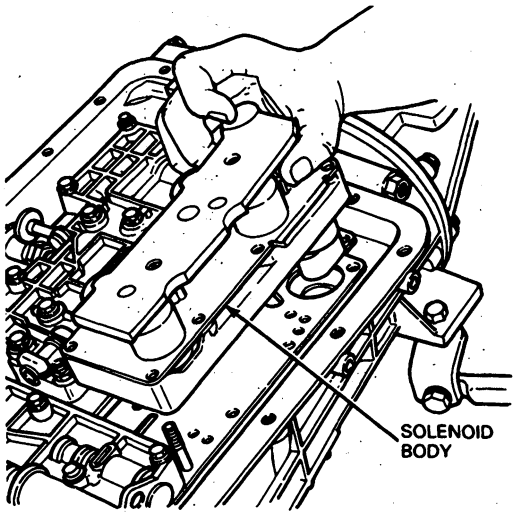
D9048-1A

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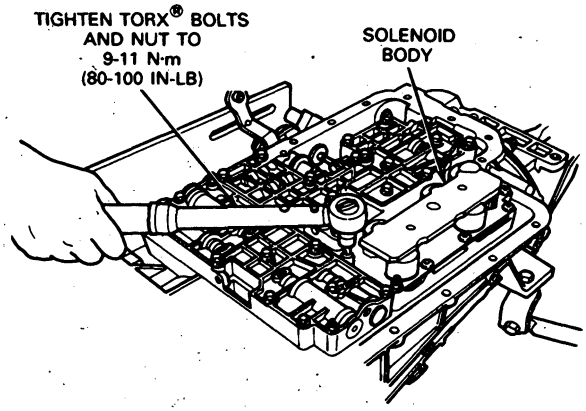
DISASSEMBLY AND ASSEMBLY (Continued)

62. Install solenoid body over stud and attach with nine Torx® bolts (30A bit) and one nut (10mm socket). Tighten to 9-11 N·m (80-100 in-lb).

NOTE: Prior to installing solenoid body assembly, coat the case connector bore with M1C172-A grease or equivalent.

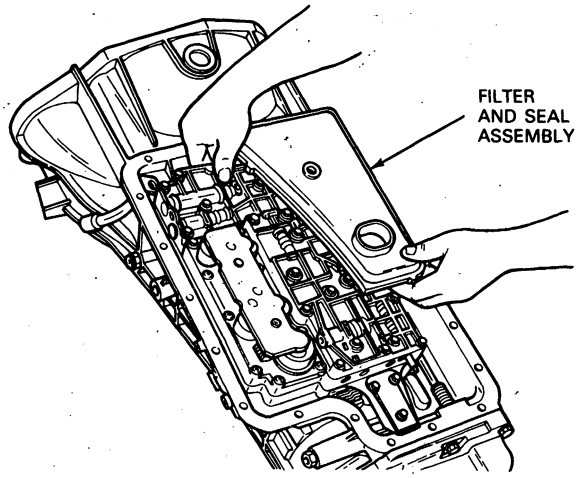


D9049-1A



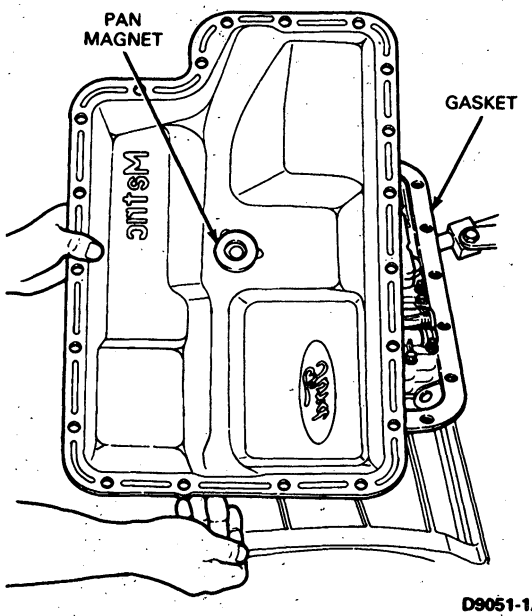
D9050-1A

63. Install a new filter and seal assembly by lubricating the seal with transmission fluid and pressing the filter into place. Do not reuse old filter or seal.



D8955-1A

64. Place pan magnet on dimple in bottom of pan. Install new pan gasket. Use grease to hold in place.

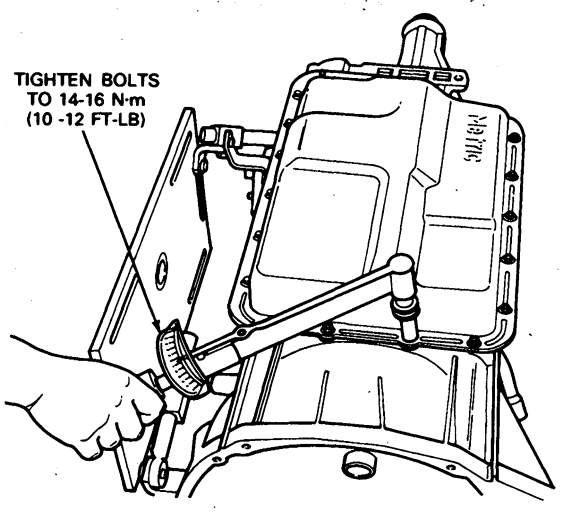


D9051-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

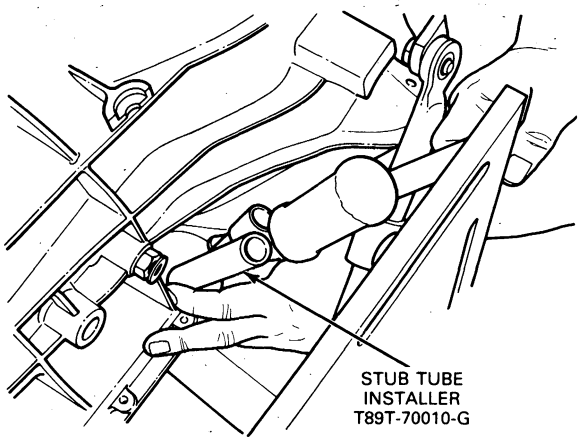
65. Attach pan with 20 bolts (10mm socket). Tighten bolts to 14-16 N·m (10-12 ft-lb).



D9052-1A

66. If necessary, install stub tube using Stub Tube Installer T89T-70010-G or equivalent.

    Use stripe on side of tube for alignment. The stripe should be farthest outboard when installed.

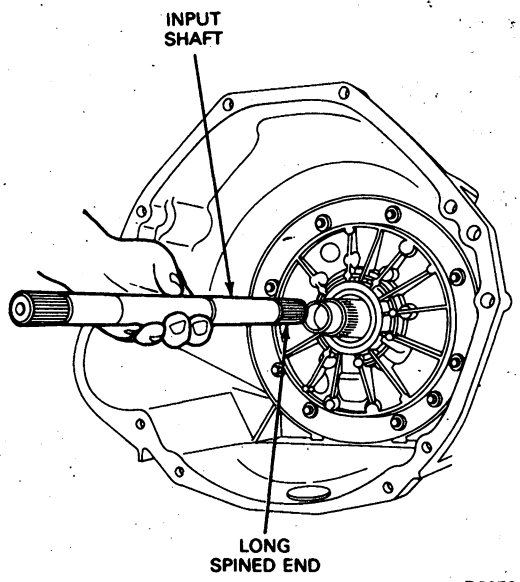


D9053-1A

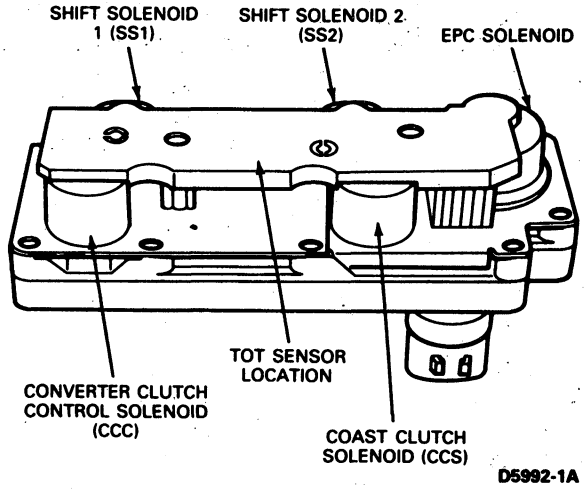
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DISASSEMBLY AND ASSEMBLY (Continued)

67. Reinstall input shaft, long splined end first.



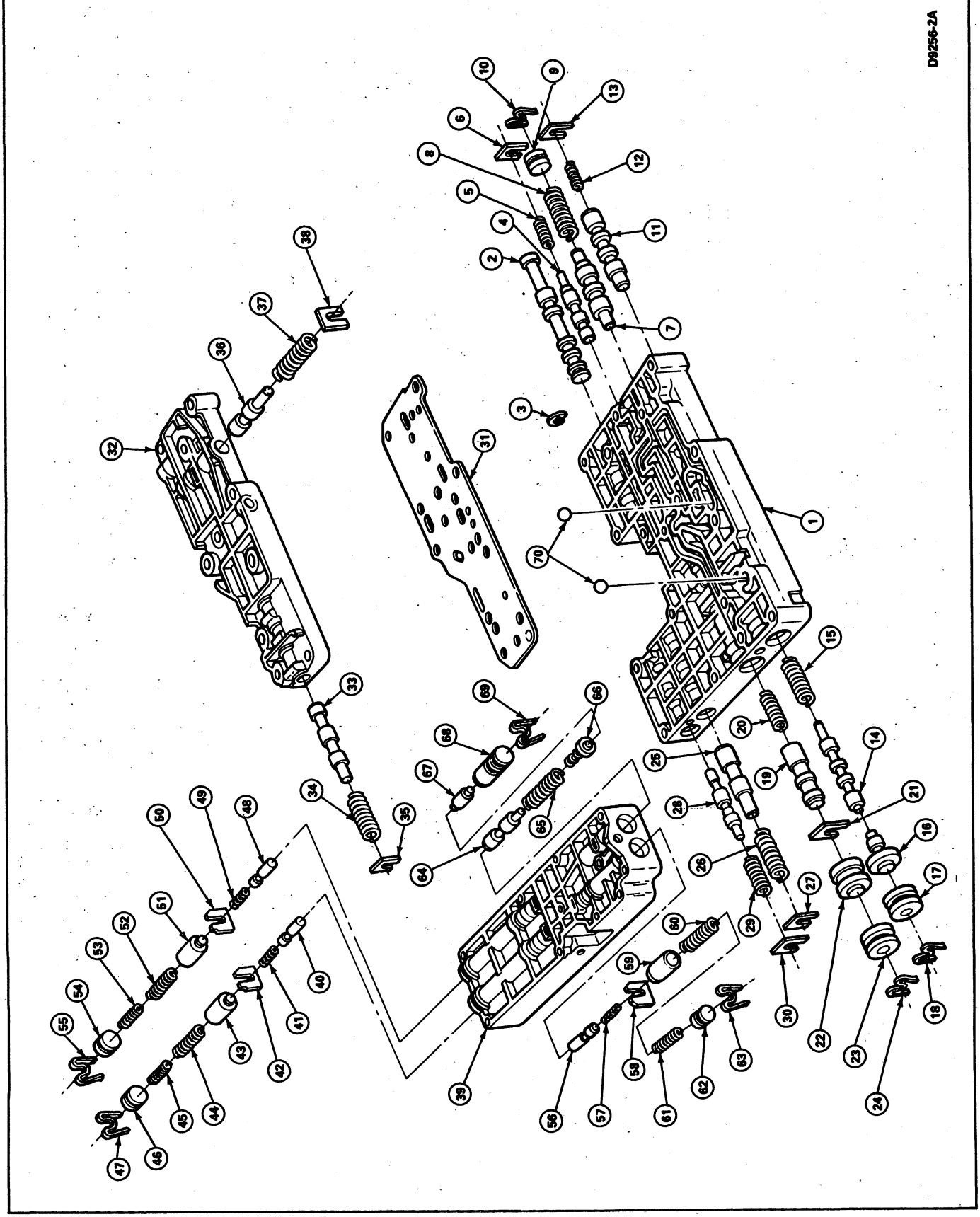
Solenoid Valve Body



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DISASSEMBLY AND ASSEMBLY (Continued)

Main Control Valve Body and Valve Body



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DISASSEMBLY AND ASSEMBLY (Continued)

Legend—Main Control Valve Body and Valve Body

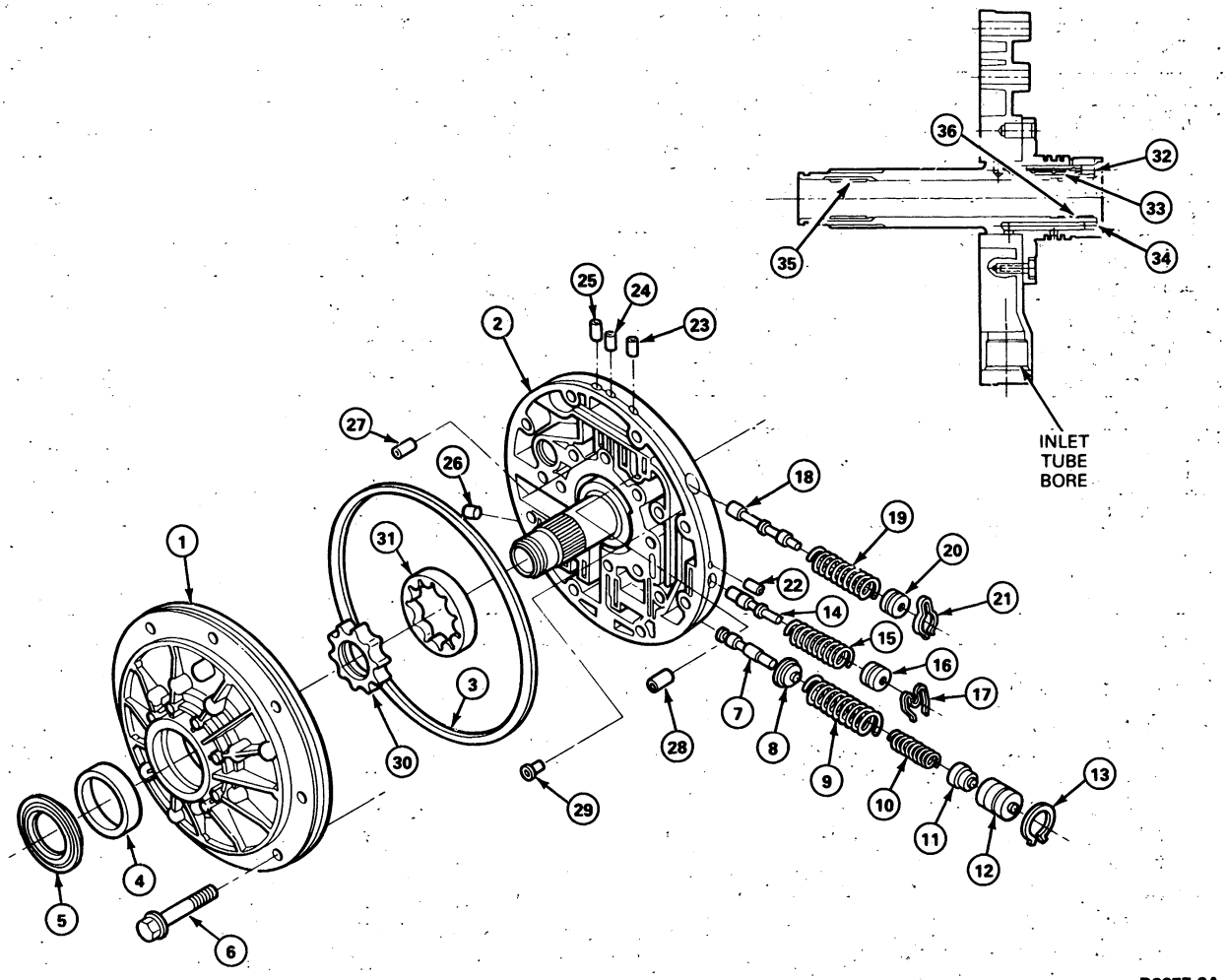
Description	Part Number	Description	Part Number
1. Main Control Body	7A092	36. 1-2 Manual Transition Valve	7G414
2. Manual Valve	7340	37. Spring	7K721
3. Retainer	97411-S	38. Retainer	7F194
4. Low/Reverse Modulator Valve	7E238	39. Accumulator Body	7G393
5. Spring	7E338	40. Overdrive Clutch Accumulator Regulator Valve	7G321
6. Retainer	7F194	41. Spring	7G310
7. 3-4 Shift Valve	7F259	42. Retainer	7G409
8. Spring	7K721	43. Overdrive Clutch Accumulator Plunger	7G322
9. Plug	7F187	44. Outer Spring	7G394
10. Clip	7E335	45. Inner Spring	7G395
11. 2-3 Shift Valve	7D053	46. Plug	7F187
12. Spring	7A320	47. Clip	7E335
13. Retainer	7F194	48. Direct Clutch Accumulator Regulator Valve	7G321
14. D2 Shift Valve	7D368	49. Spring	7G310
15. Spring	7A288	50. Retainer	7G409
16. 1-2 Shift Valve	7A334	51. Direct Clutch Accumulator Plunger	7G322
17. Plug	7F187	52. Outer Spring	7G394
18. Clip	7E335	53. Inner Spring	7G395
19. 4-3-2 Manual Timing Valve	7G398	54. Plug	7F187
20. Spring	7G410	55. Clip	7E335
21. Retainer	7G396	56. Intermediate Clutch Accumulator Regulator Valve	7G321
22. 4-3-2 Manual Timing Plunger	7G399	57. Spring	7G310
23. Plug	7F187	58. Retainer	7G409
24. Clip	7E335	59. Intermediate Clutch Accumulator Plunger	7G322
25. Coast Clutch Shift Valve	7G416	60. Outer Spring	7G394
26. Spring	7K721	61. Inner Spring	7G395
27. Retainer	7F194	62. Plug	7F187
28. Solenoid Regulator Valve	7G392	63. Clip	7E335
29. Spring	7G411	64. Line Pressure Modulator Valve	7G408
30. Retainer	7F194	65. Outer Spring	7G314
31. Separator Plate	7A008	66. Spring and Retainer Assembly	7H149
32. Lower Control Body	7A101	67. Line Pressure Modulator Plunger Valve	7G415
33. Engagement Control Valve	7G317	68. Line Pressure Modulator Sleeve	7G407
34. Spring	7G312	69. Clip	7E335
35. Retainer	7F194	70. Check Ball	7E195

CD9274-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

Subassemblies
Pump



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DISASSEMBLY AND ASSEMBLY (Continued)

Description	Part Number	Description	Part Number
1. Pump Body	7A105	20. Plug	7F187
2. Control Body	7G406	21. Clip	7E335
3. Square Cut O.D. Pump Seal	7D441	22. Solid Cup Plug	N805212
4. Converter Hub Bushing	7B258	23. Solid Cup Plug	N805212
5. Seal	7A248	24. Solid Cup Plug	N805212
6. Bolt and Washer Assembly	N805260	25. Solid Cup Plug	N805212
7. Main Regulator Valve	7C338	26. Solid Cup Plug	N805212
8. Spring Retainer	7E337	27. Orificed Cup Plug (.077-.083 inch diameter orifice)	N805213
9. Outer Spring (Green)	7A270	28. Orificed Cup Plug (.049-.055 inch diameter orifice)	N805214
10. Inner Spring (Green)	7G498	29. Air Bleed Check Valve Assembly	7H000
11. Main Regulator Booster Valve	7D003	30. Inner Gerotor Gear	7C010
12. Main Regulator Booster Sleeve	7D002	31. Outer Gerotor Gear	7C011
13. Retainer	N660225	32. Orifice Cup Plug (.057-.062 inch diameter orifice)	N805802
14. Converter Regulator Valve	7G307	33. Valve Assembly	7A250
15. Spring (White)	7G316	34. Solid Cup Plug	N805175
16. Plug	7F187	35. Front Input Shaft Bushing	7B261
17. Clip	7G007	36. Rear Input Shaft Bushing	7D018
18. Converter Clutch Control Valve	7L318		
19. Spring (Yellow)	7L490		

CD9278-2A

Pump Disassembly

1. Remove two Teflon® coast clutch seals from stator support. Remove converter clutch seal from front of stator support. Remove pump outer diameter square cut seal.
2. Obtain a banding tool prior to removing pump body bolts. This tool is needed to align the pump with the control body assembly during re-assembly.
3. Remove eleven bolts and separate pump control body from pump body.

   For Steps 4 through 6 refer to pump control body assembly illustration.
4. Apply pressure to main regulator booster sleeve and remove internal snap ring. Remove main regulator valve train.
5. Remove converter regulator valve assembly by applying pressure to end plug and removing retainer clip with small screwdriver or tweezers.
6. Remove converter clutch shift valve assembly by applying pressure to end plug and removing retainer clip with small screwdriver or tweezers.

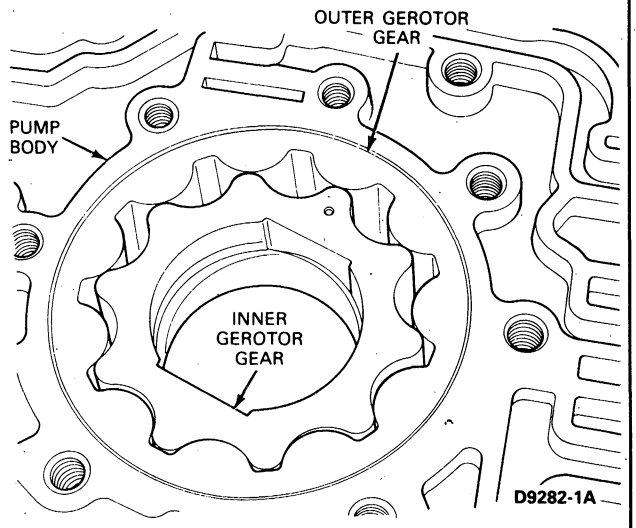
NOTE: DO NOT remove any of the cup plugs unless they are damaged or leaking.

NOTE: DO NOT remove stator support from control body as this may distort the surface of the control body.

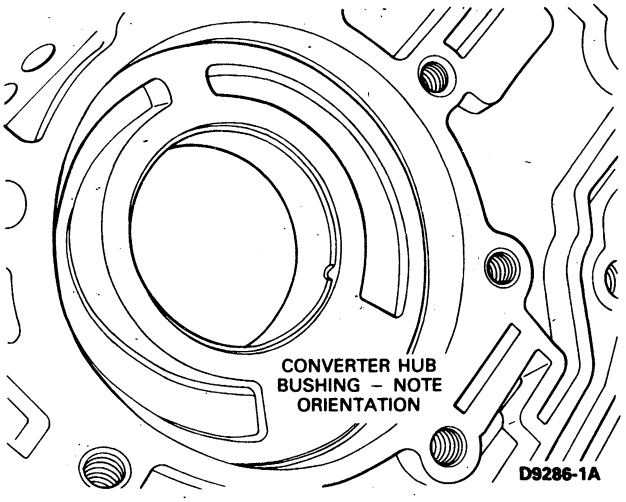
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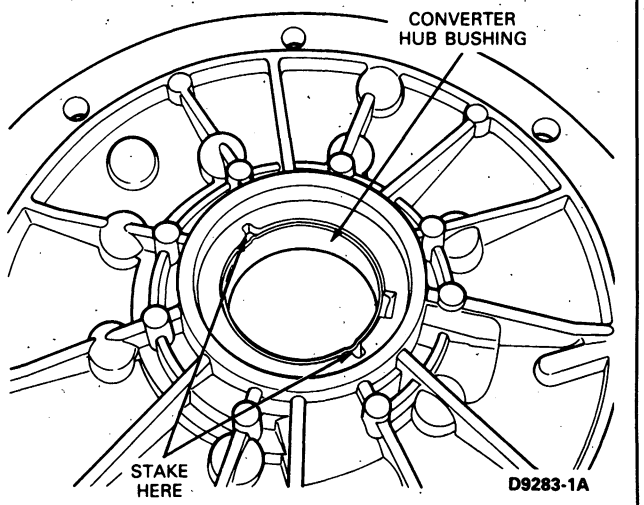
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove gerotor gearset from pump body.

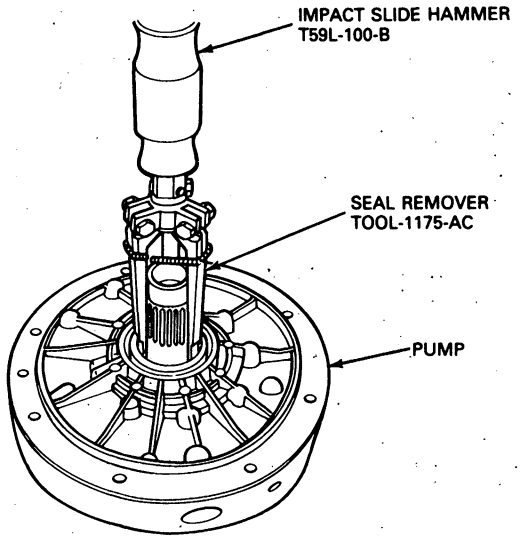


8. Remove gasket material from control body surface. Clean all pump parts in solvent and dry with compressed air.
9. Inspect pump gears, faces, gear teeth, pump housing and mating surfaces for damage or scoring. Replace entire pump if any part is damaged or worn.
10. Inspect converter hub bushing. Replace if scored or excessively worn. Install as shown. Stake bushing at notches.





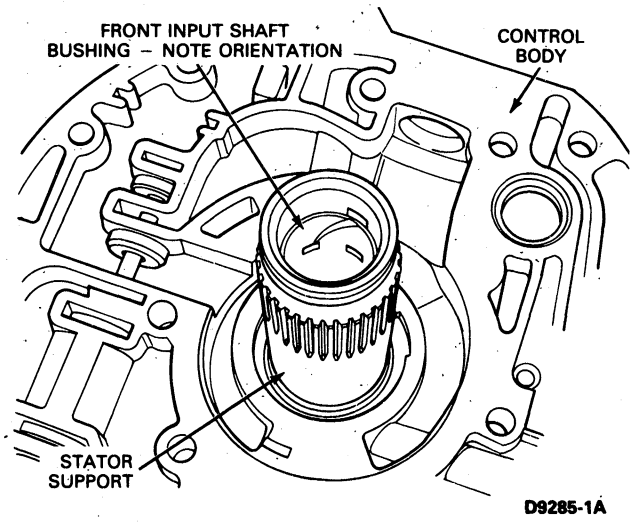
11. Inspect converter hub seal. If damaged, remove with Impact Slide Hammer Tool no. T59L-100-B and Seal Remover Tool no. 1175-AC. Install new seal with Seal Installer Tool no. T63L-77837-A.

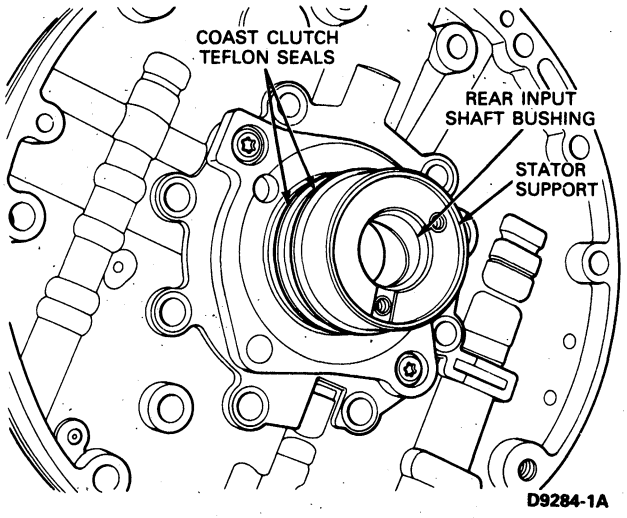


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DISASSEMBLY AND ASSEMBLY (Continued)

12. Inspect stator input shaft bushings. If bushings are worn or scored, replace complete control body assembly.



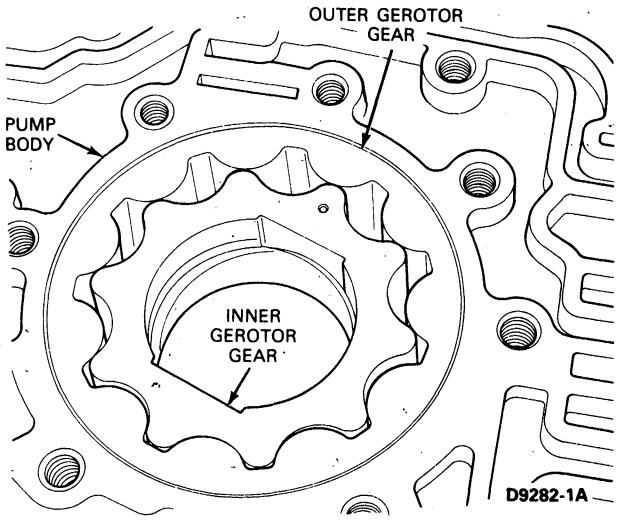


13. Inspect all valve and plug bores for scoring, or damage. Check all passages for obstructions. Inspect mating surfaces for burrs and scoring. If necessary, use crocus cloth to polish components. Use caution to avoid rounding sharp edges of valves and plugs.
14. Inspect all springs for distortion. Check all valves and plugs that when dry they fall freely from their bores.

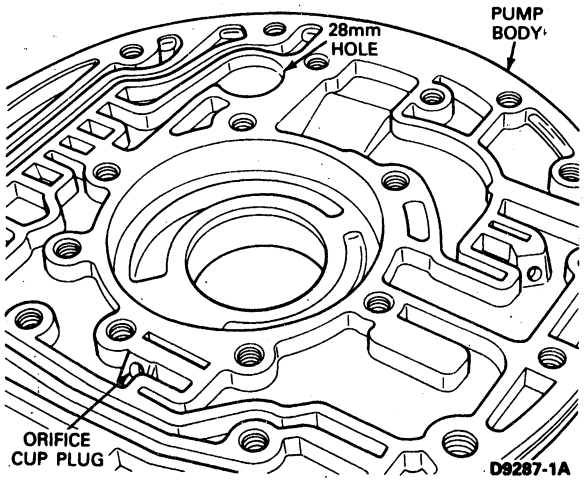
Assembly

1. Install main regulator valve assembly as shown in control body assembly drawing. Apply pressure to main regulator booster sleeve and install internal snap ring. Ensure snap ring is properly seated.
2. Install converter shuttle valve assembly as shown in pump exploded view.

3. Lightly coat the gerotor gears and install in pump housing. The dot on the inner gerotor gear must face the control body assembly.

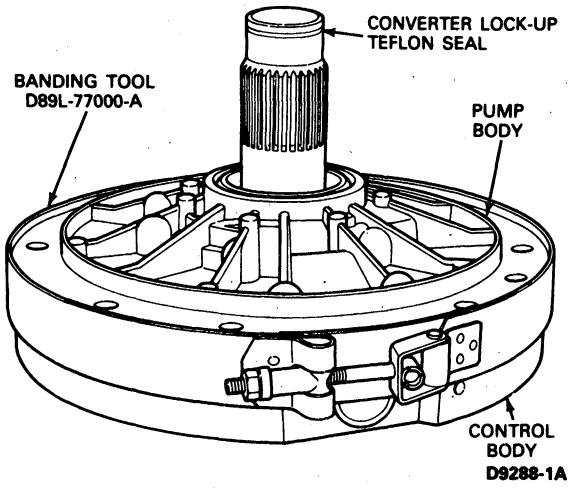


4. Inspect mating surfaces of pump body and control body to be sure they are clean and free of nicks and burrs. Lower the control body and stator assembly onto the pump body, aligning the 28mm round hole in the control body with the 28mm hole in the pump body.
5. Loosely install eleven M8x50 bolts into pump body. Install banding tool no D89L-77000- or equivalent with clamp by filter inlet. Align outer bolt holes and tighten banding tool. (This aligns input shaft bushings to the converter hub bushings.)
6. Tighten bolts to 24-31 N·m (18-23 ft. lbs.) and remove banding tool. Ensure the outer edges of the control body and the pump body are completely aligned.

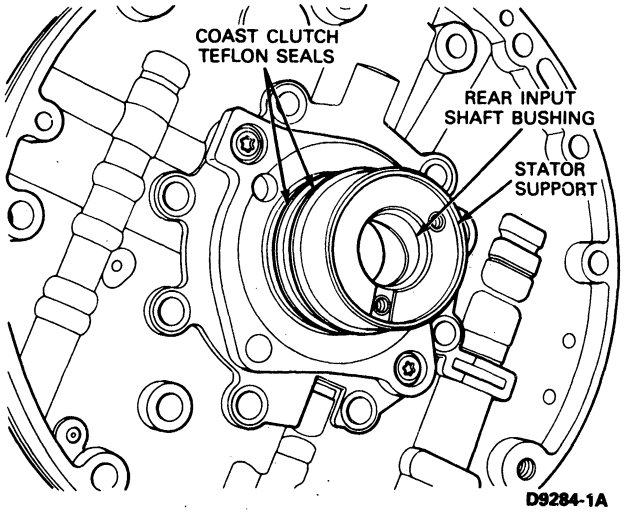


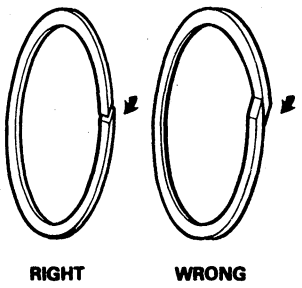
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DISASSEMBLY AND ASSEMBLY (Continued)

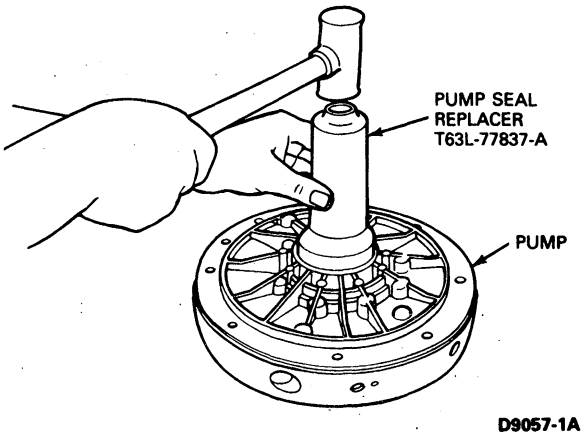


7. Install coast clutch Teflon® seals as shown. Install converter lock up seal on front of stator support in same manner.





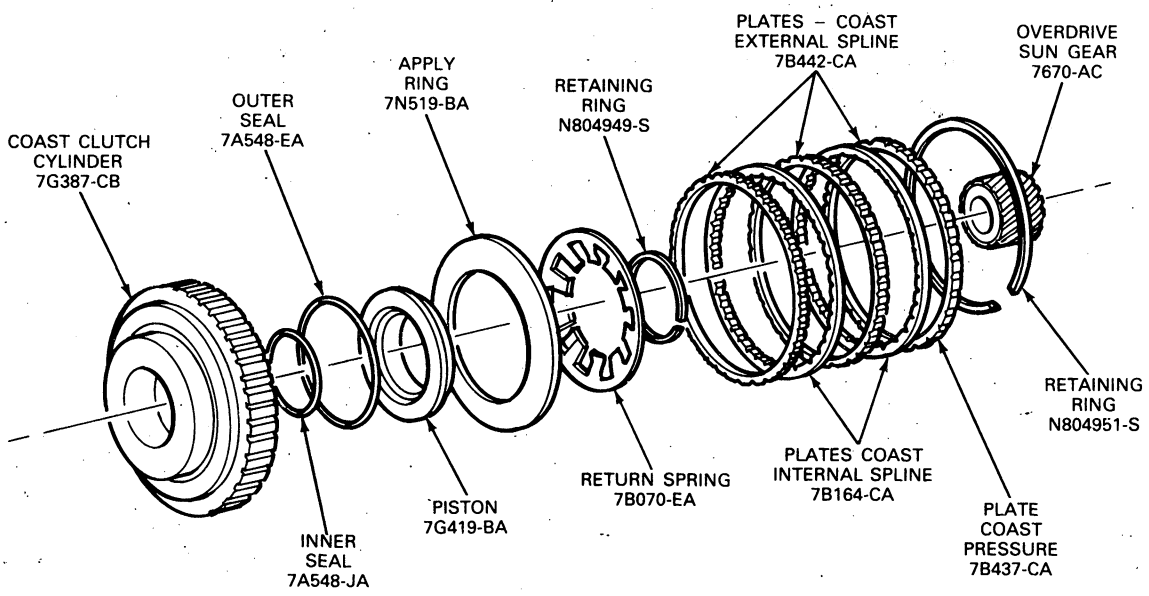
8. Install pump outer diameter seal. Be sure groove is clean and free of burrs. Lubricate outer diameter seal with transmission fluid before installing pump into transmission case.



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DISASSEMBLY AND ASSEMBLY (Continued)

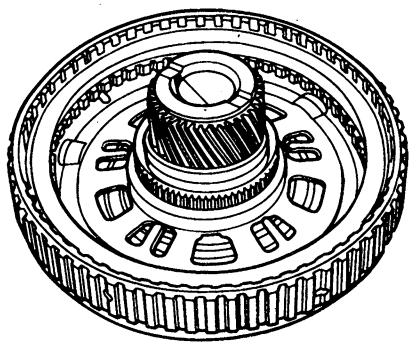
Coast Clutch Cylinder Assembly



Disassembly

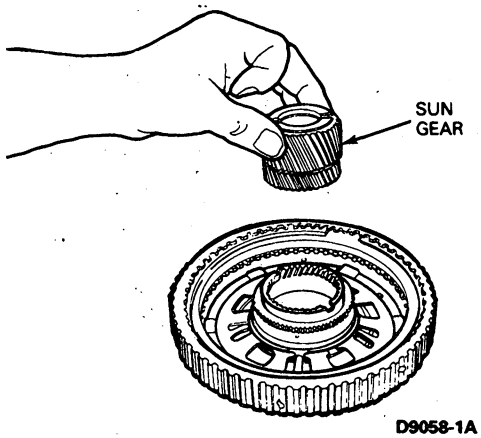
1. Complete assembly shown.

COAST CLUTCH CYLINDER ASSEMBLY



D6480-1A

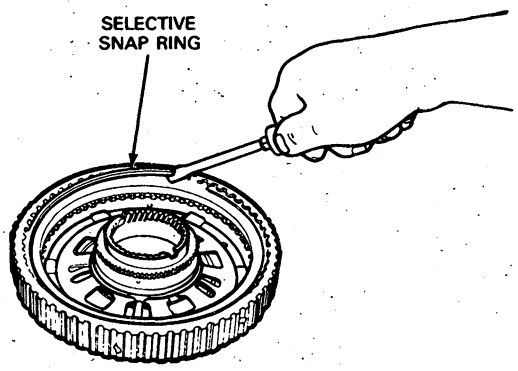
2. Remove sun gear assembly from coast clutch cylinder.



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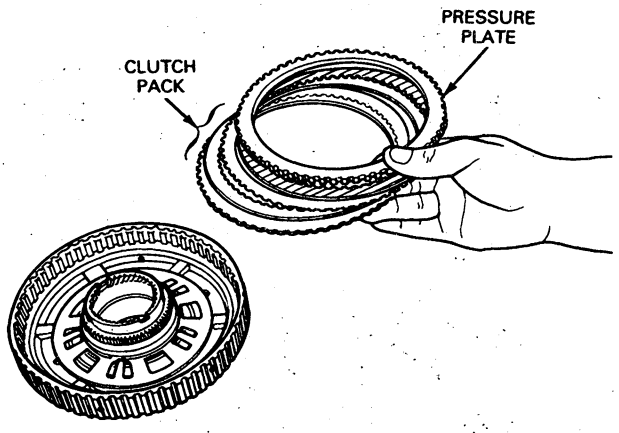
DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove snap ring and discard.



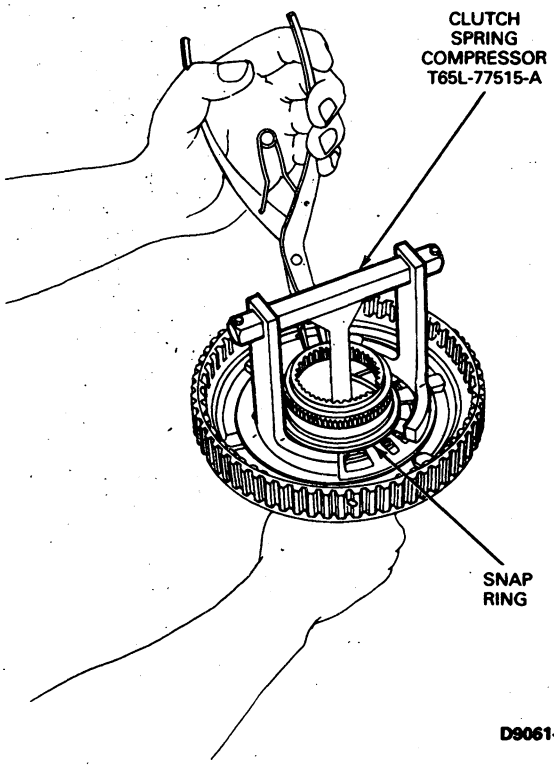
D9059-1A

4. Remove pressure and clutch plates from cylinder. Tag for re-assembly.



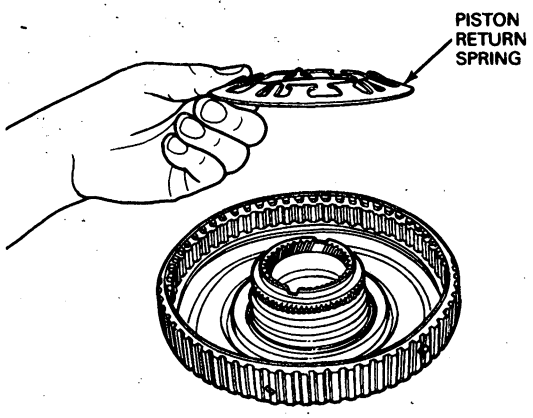
D9060-1A

5. Using Clutch Spring Compressor T65L-77515-A or equivalent remove return spring retaining ring. Remove compressor tool.



D9061-1A

6. Remove piston return spring.

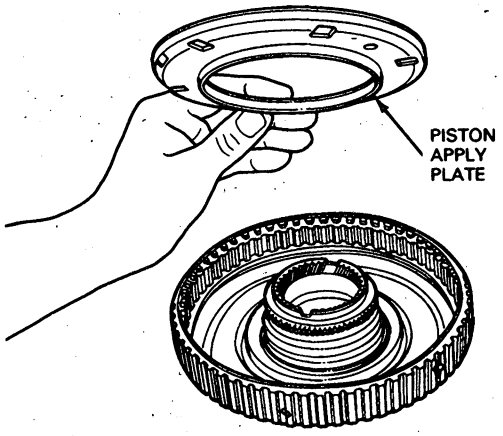


D9062-1A

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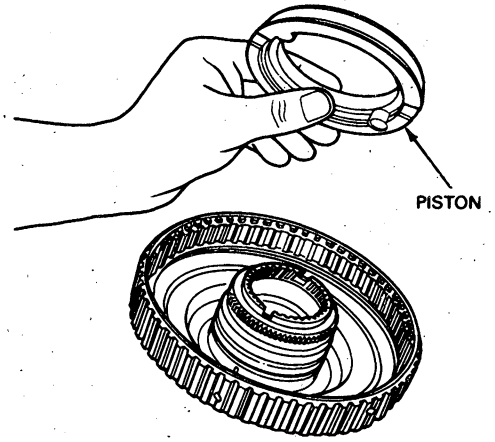
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove piston apply plate.



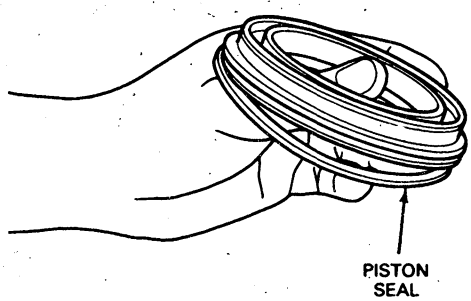
D9063-1A

8. Remove piston from cylinder.



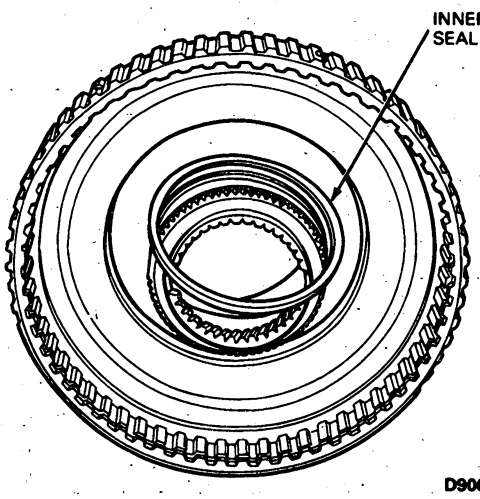
D9064-1A

9. Remove outer seal from piston.



D9065-1A

10. Remove inner seal from cylinder.



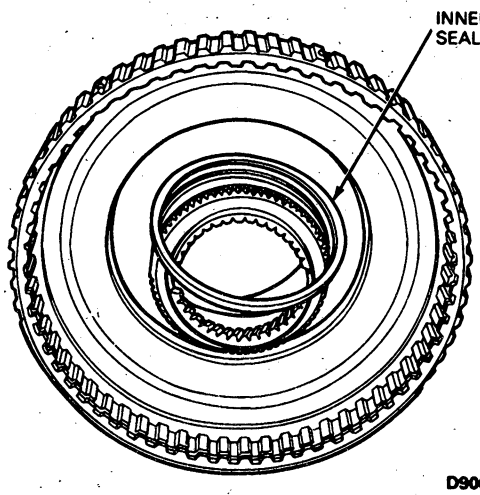
D9066-1A

Assembly

NOTE: Soak all friction plates in clean transmission fluid ESP-M2C166-H or equivalent for 15 minutes.

Lightly lube all O-ring seals before installing using transmission fluid ESP-M2C66-H or equivalent.

1. Install inner seal so that lip is facing toward bottom (down) into cylinder.

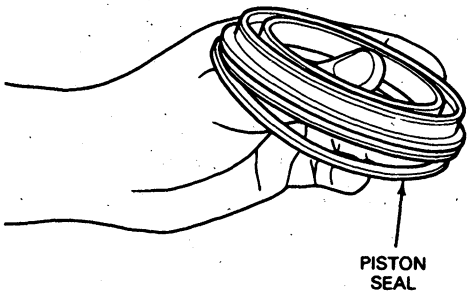


D9066-1A

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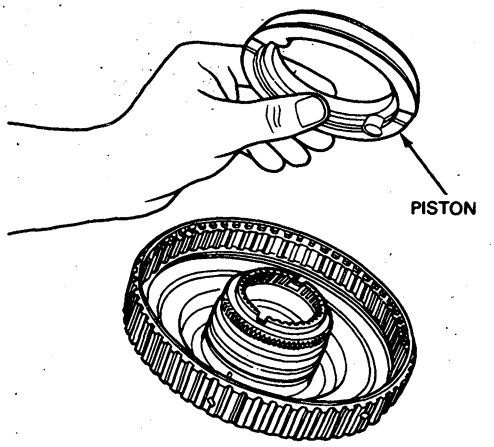
DISASSEMBLY AND ASSEMBLY (Continued)

2. Install outer seal so that lip is facing toward bottom (down) onto piston.



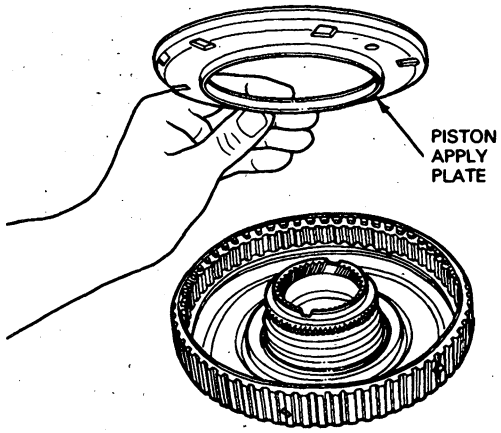
D9065-1A

3. Install piston into cylinder.



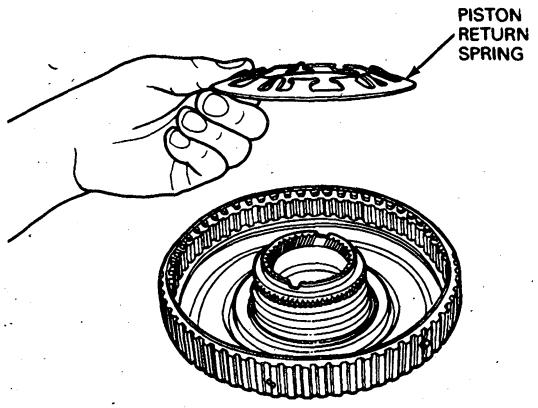
D9064-1A

4. Install piston apply plate.



D9063-1A

5. Install piston return spring.

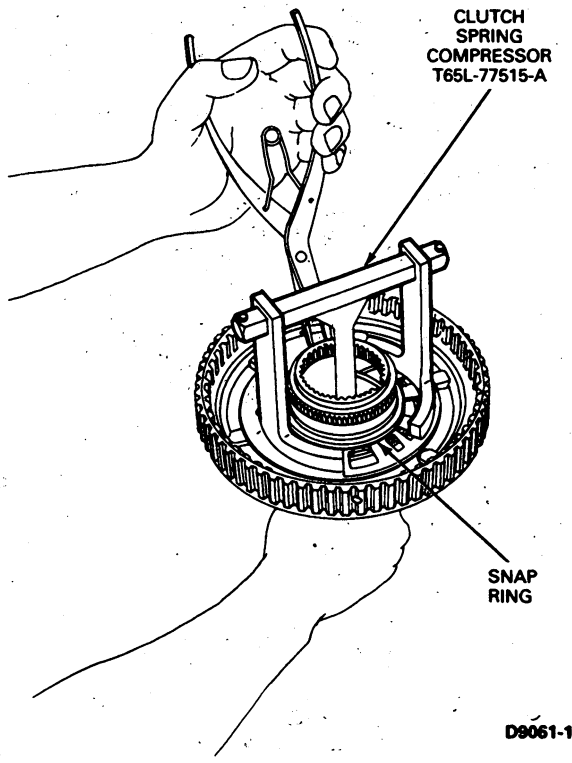


D9062-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

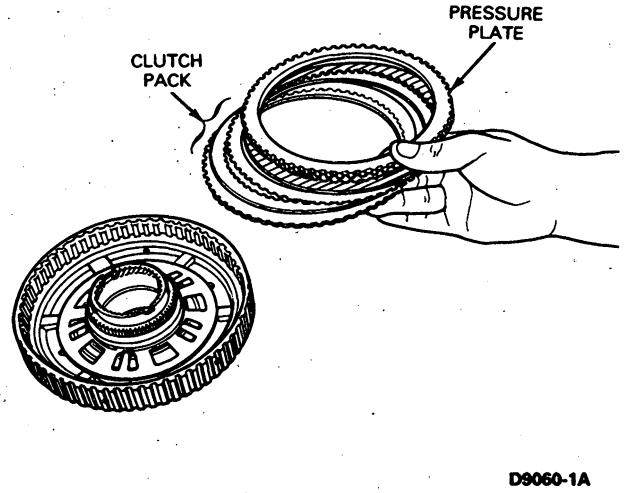
6. Using Clutch Spring Compressor T65L-77515-A or equivalent, install snap ring.



7. Install clutch pack plates, alternately starting with steel plate.

NOTE: Soak the clutch plates in clean transmission fluid (Ford Specification Mercon® ESP-M2C1166-H) or equivalent, for 15 minutes.

8. Install pressure plate.



9. Install selective snap ring and check stack-up using feeler gauge. If not within specification, install correct selective snap ring and recheck.

Specification:

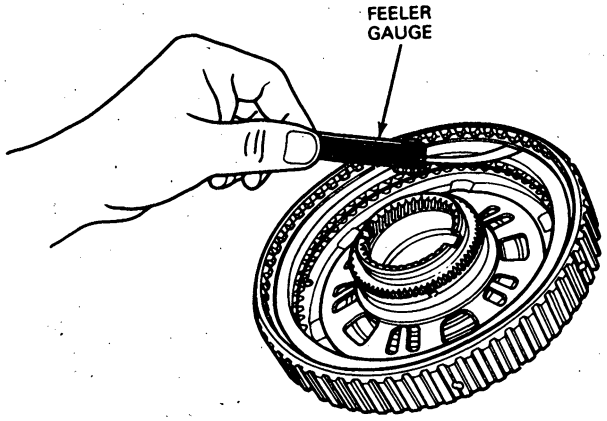
1.14 - 0.62mm (0.045 - 0.025 inch)

Selective Snap Rings

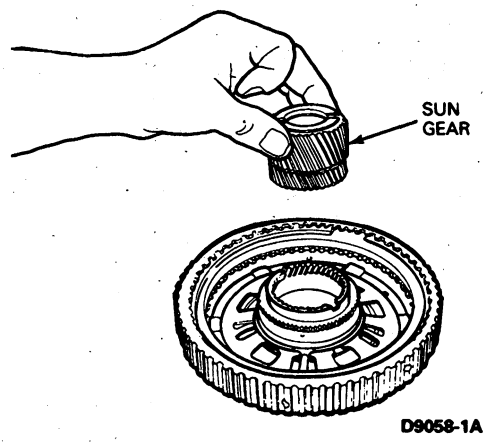
1.45 - 1.35mm (0.057 - 0.053 inch)

1.85 - 1.75mm (0.072 - 0.068 inch)

2.25 - 2.15mm (0.088 - 0.084 inch)



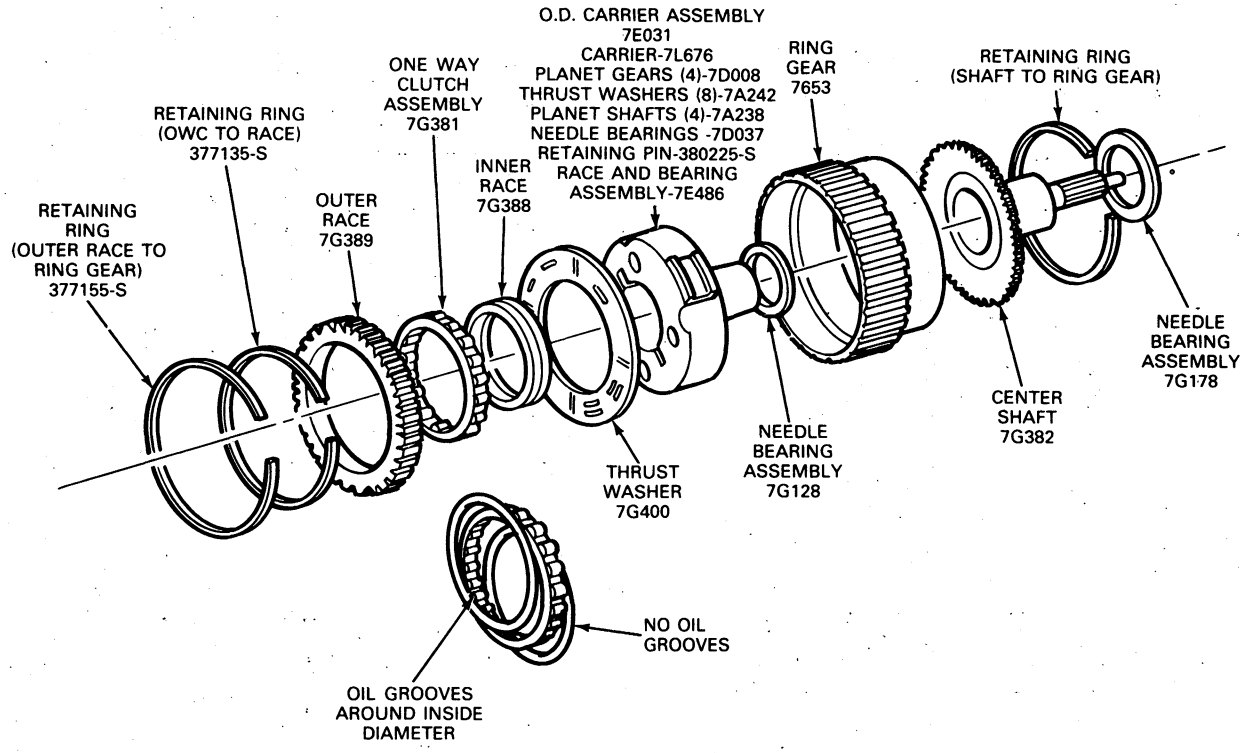
10. Install overdrive sun gear with short end of gear down into coast clutch cylinder.



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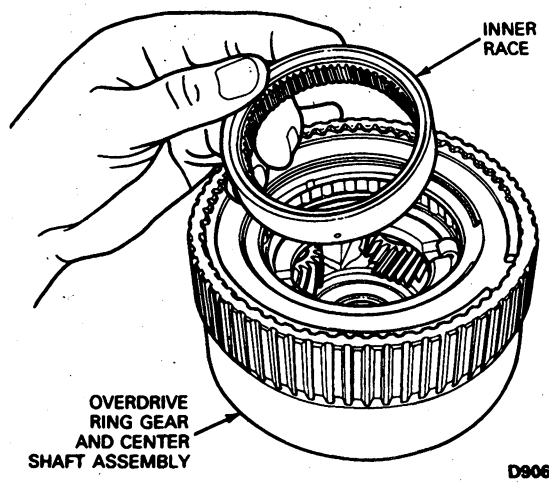
DISASSEMBLY AND ASSEMBLY (Continued)

Overdrive Ring Gear And Center Shaft Assembly

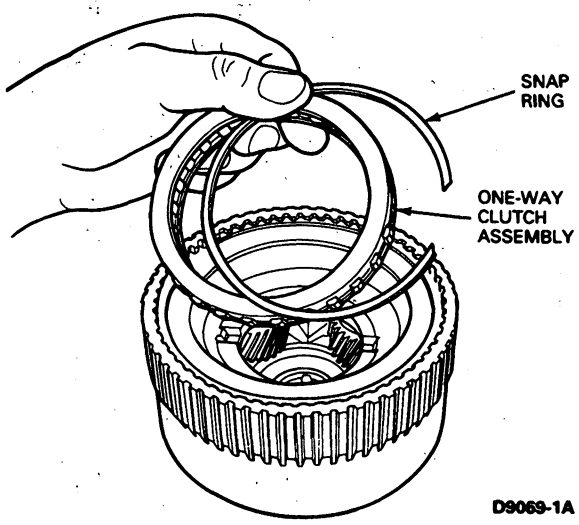


Disassembly

1. Remove inner race.



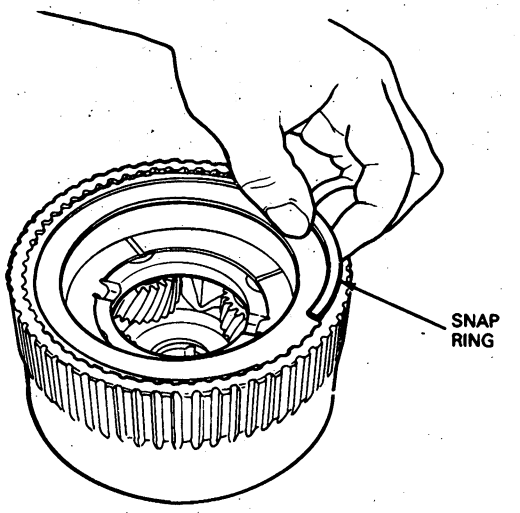
2. Remove small (inner) snap ring and one-way clutch assembly.



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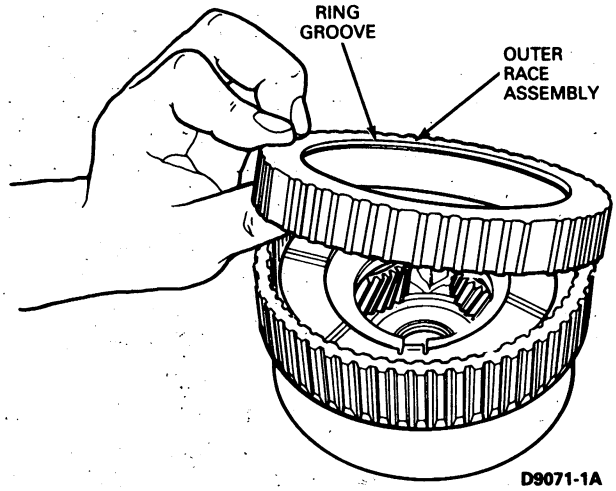
DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove large snap ring.



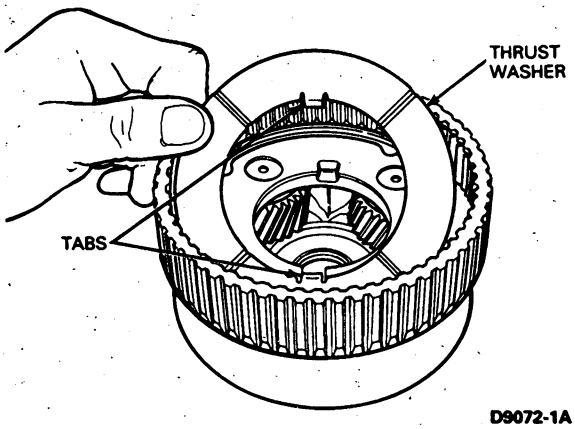
D9070-1A

4. Remove outer race assembly from ring gear.



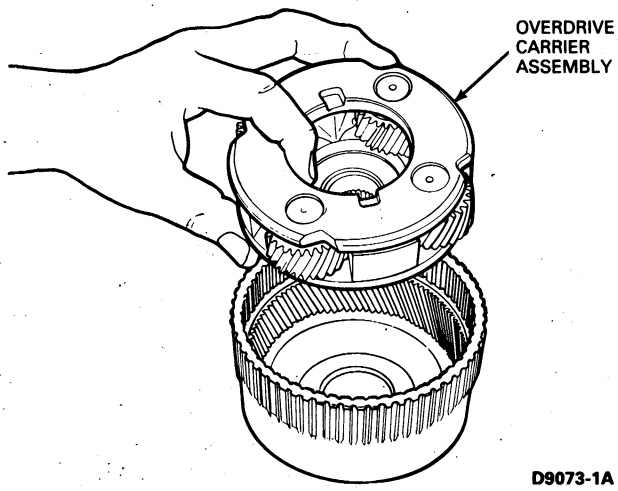
D9071-1A

5. Remove thrust washer No. 7G400 from front of carrier.



D9072-1A

6. Remove overdrive carrier from ring gear assembly.

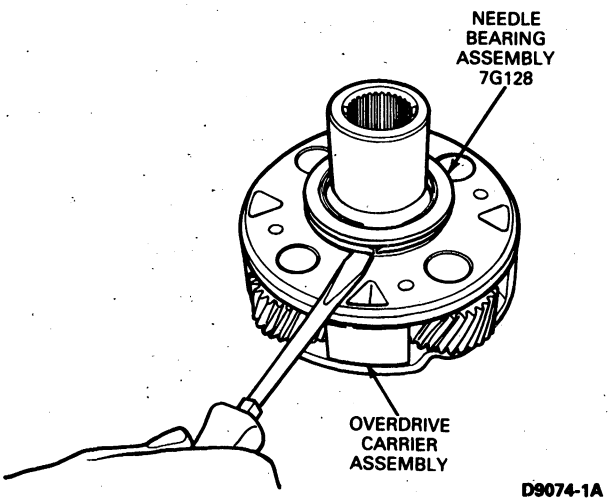


D9073-1A

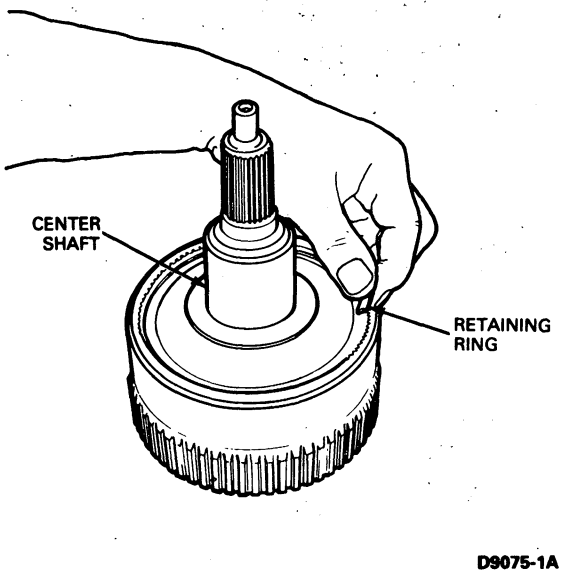
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DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove needle bearing assembly No. 7G128 from rear face of carrier, using screwdriver.

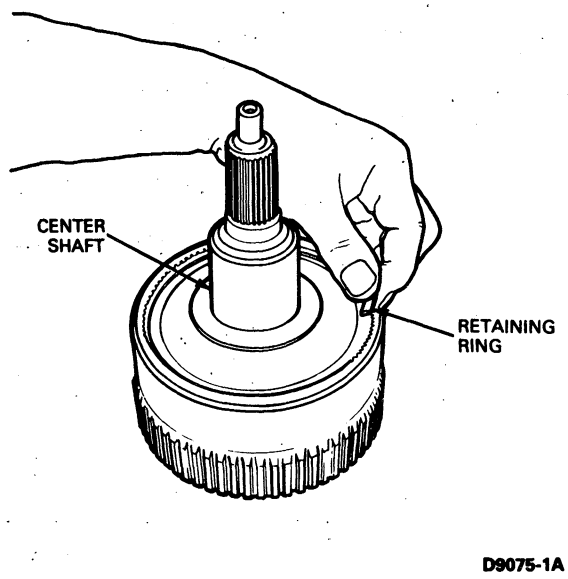


8. Remove center shaft to ring gear wave-type snap ring.
9. Remove center shaft from ring gear.

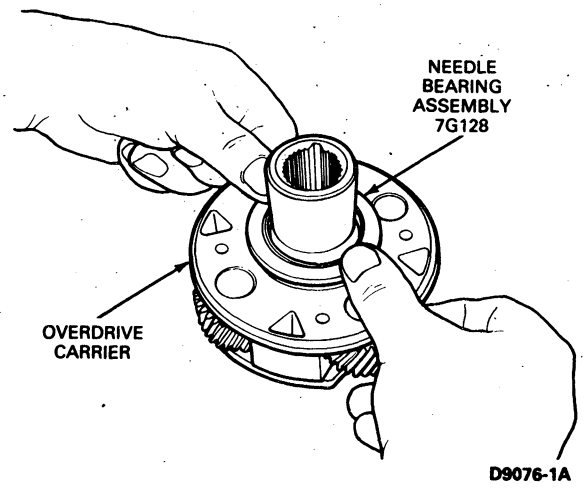


Assembly

1. Install center shaft into overdrive ring gear.
2. Install center shaft to ring gear with retaining ring.



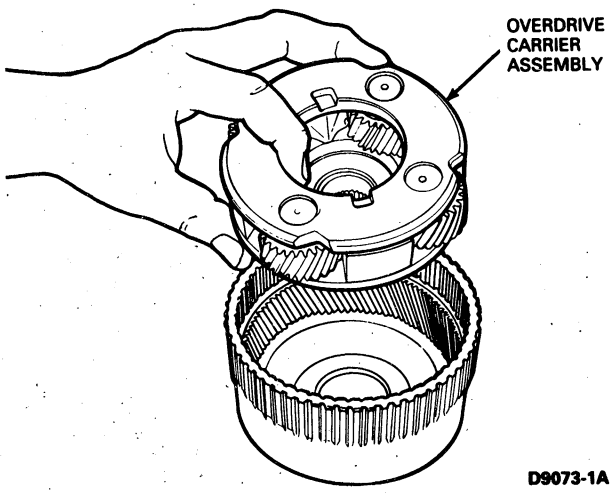
3. Install needle bearing assembly No. 7G128 on rear face of carrier.



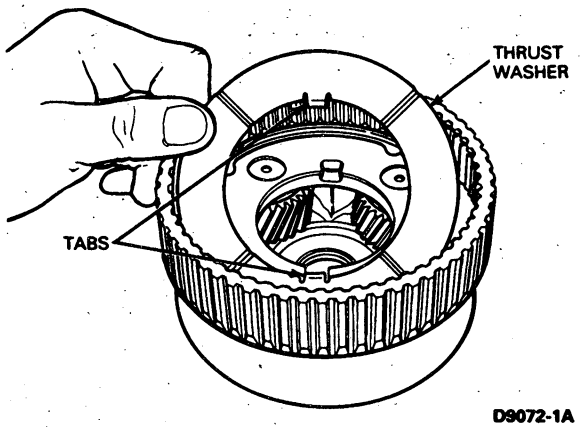
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DISASSEMBLY AND ASSEMBLY (Continued)

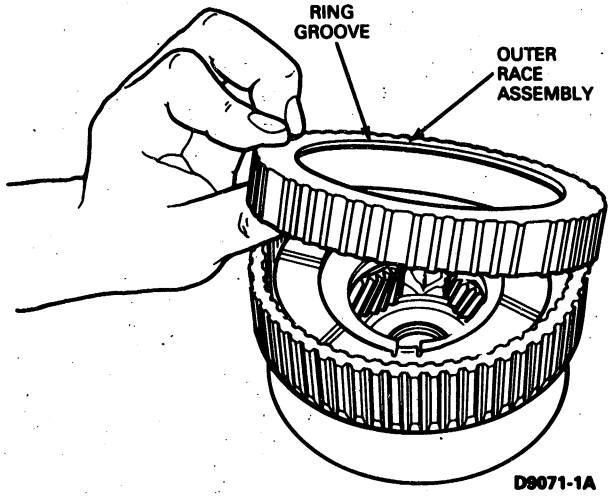
4. Install overdrive carrier into center shaft and ring gear assembly.

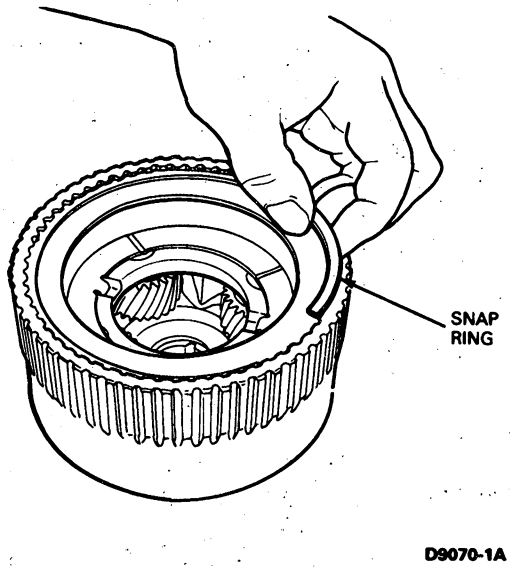


5. Install thrust washer No. 7G400 on front of carrier.



6. Install outer race assembly into ring gear with snap ring groove facing up. Attach to ring gear with snap ring.



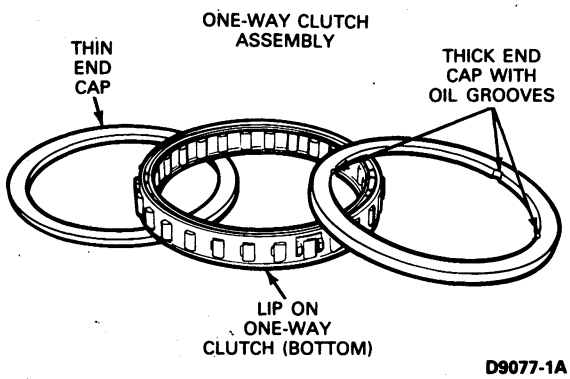


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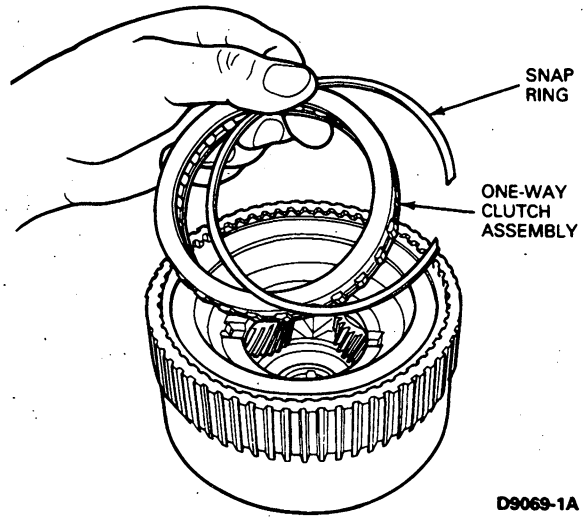
DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: E4OD overdrive one way clutch end caps must be installed as shown to achieve durability. The end cap with the scallops on the inner diameter must be toward the front of the transmission for proper lubrication.

7. Place top (thick) end cap onto one-way clutch. Place thin end cap onto bottom one-way clutch.

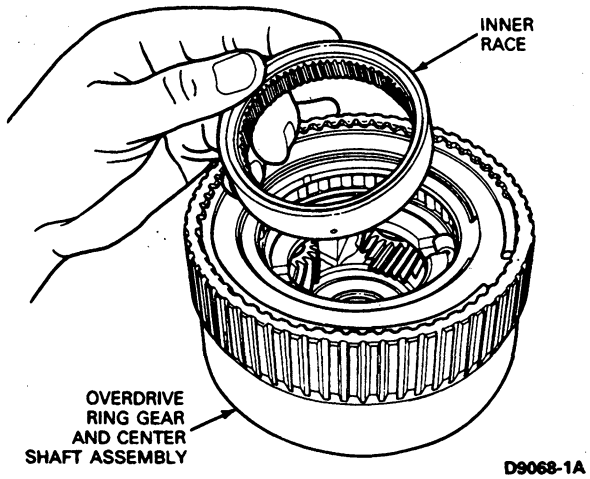


8. Install one-way clutch assembly. Date code on outside of thick end cap must be visible. Secure in place with snap ring.



9. Install inner race.

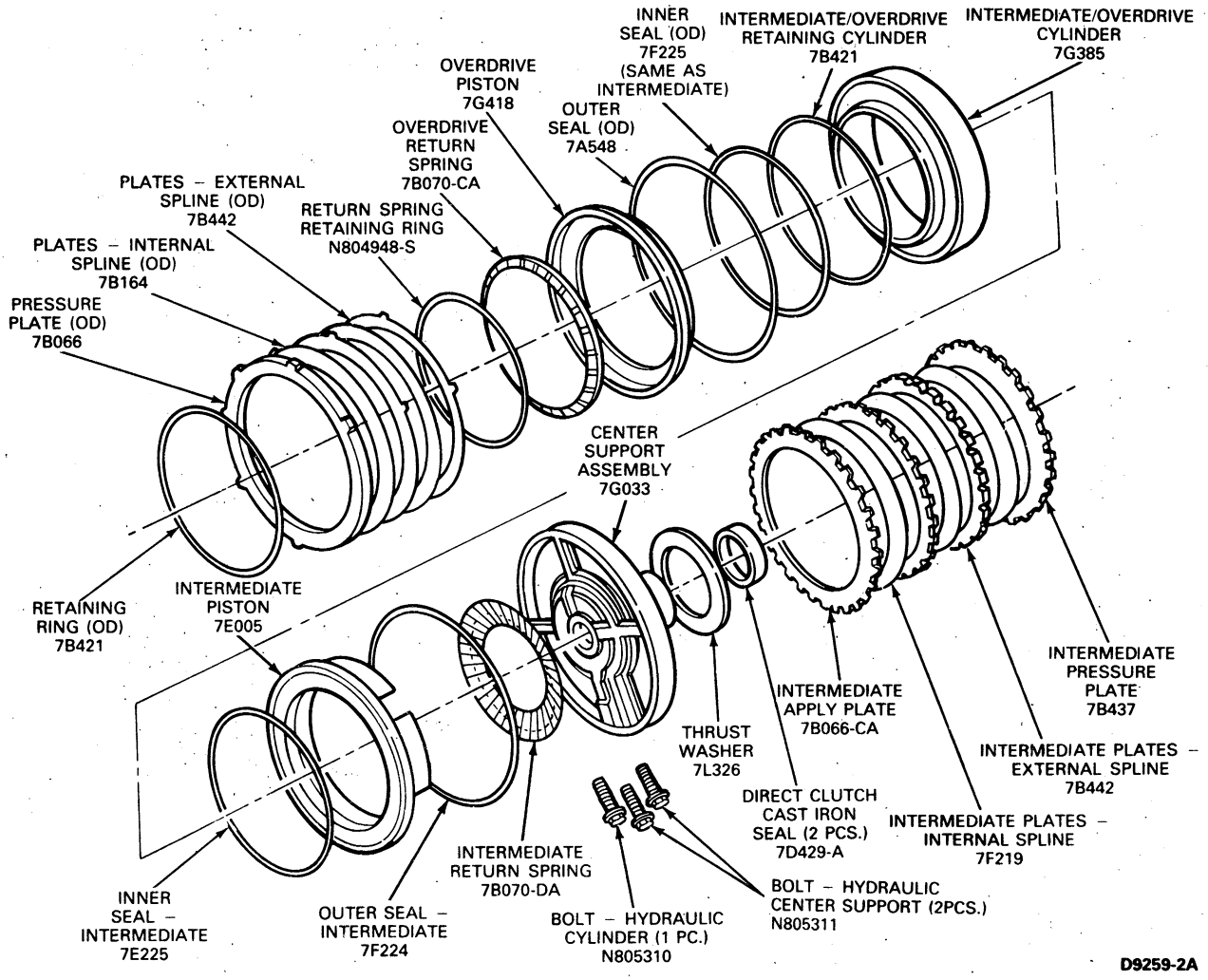
NOTE: Inner race must rotate counterclockwise.



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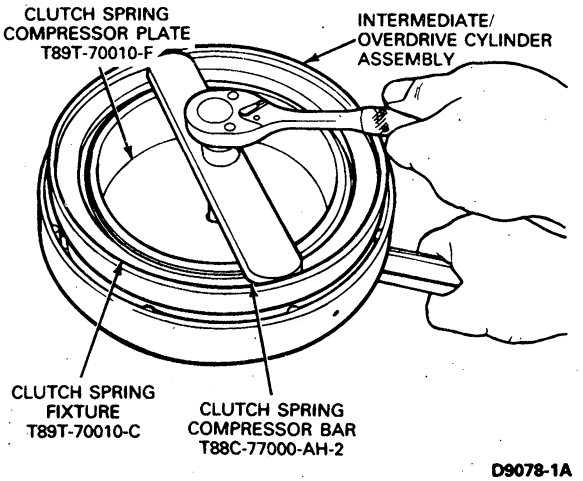
DISASSEMBLY AND ASSEMBLY (Continued)

Intermediate/Overdrive Cylinder Assembly



Disassembly

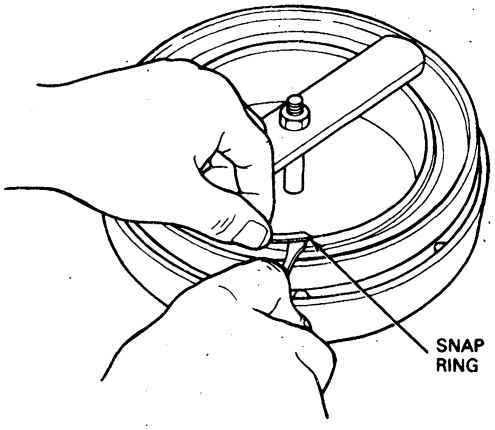
1. Using Clutch Spring Compressor Plate T89T-70010-F, Clutch Spring Compressor Bar T88C-77000-AH2 and Intermediate Clutch Spring Fixture T89T-7100-C or equivalent, compress the overdrive return spring.



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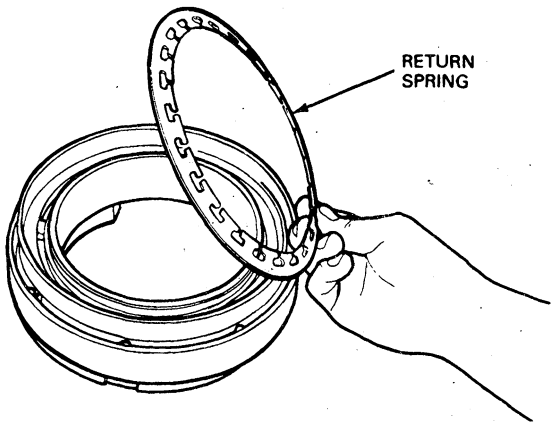
DISASSEMBLY AND ASSEMBLY (Continued)

2. Remove snap ring.



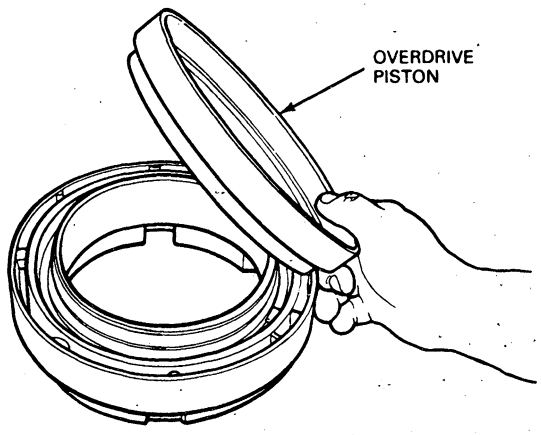
D9079-1A

3. Remove compressor tool assembly.
4. Remove return spring.



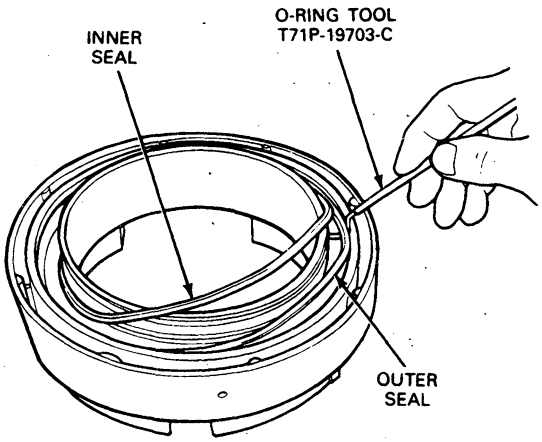
D9080-1A

5. Remove overdrive piston.



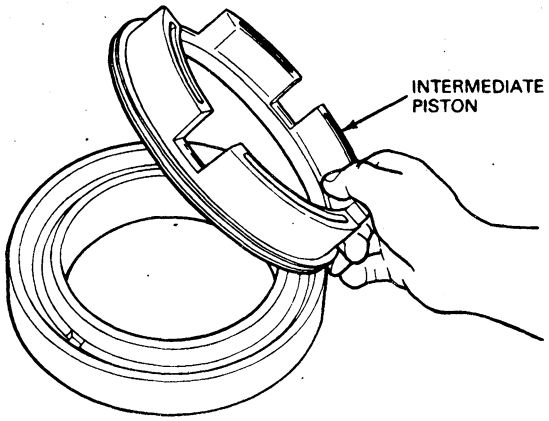
D9081-1A

6. Remove outer and inner seals, using O-ring Tool T71P-19703-C or equivalent.



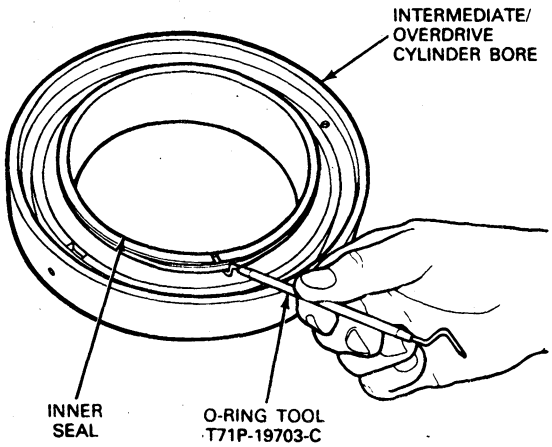
D9082-1A

7. Remove intermediate piston.



D9083-1A

8. Remove intermediate/overdrive inner seal from cylinder bore, using O-Ring Tool T71P-19703-C or equivalent.

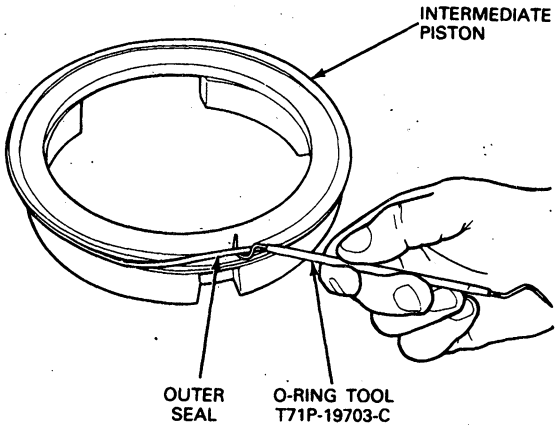


D9084-1A

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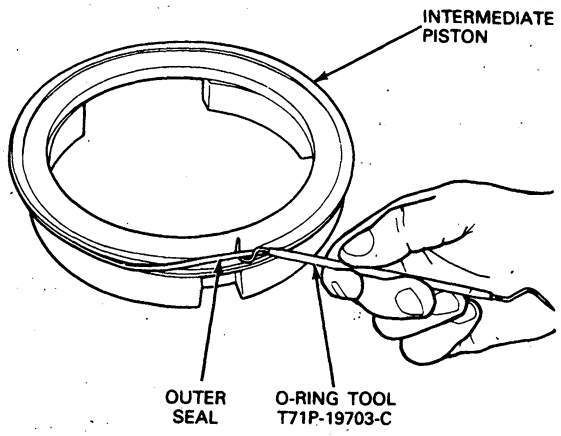
DISASSEMBLY AND ASSEMBLY (Continued)

9. Remove outer seal from intermediate piston.

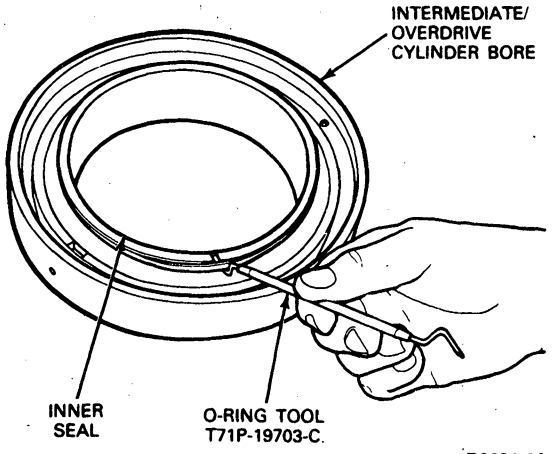


Assembly

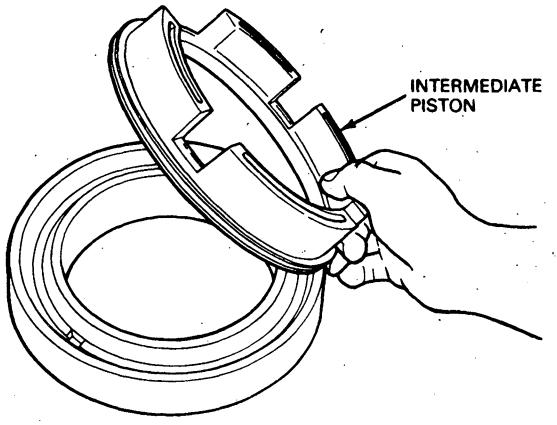
1. Install outer seal onto intermediate piston with lip seal facing down towards cylinder.



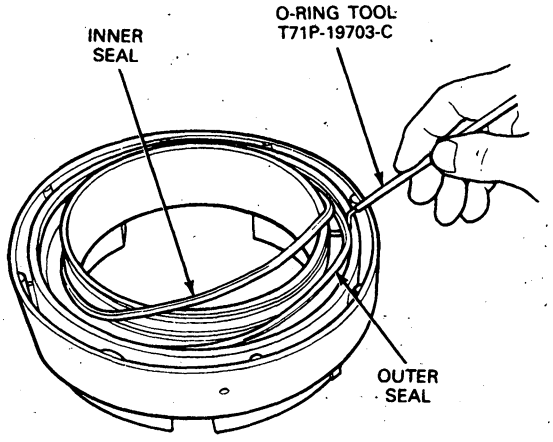
2. Install intermediate/overdrive inner seal into cylinder bore with lip seal facing down towards cylinder.



3. Install intermediate piston.



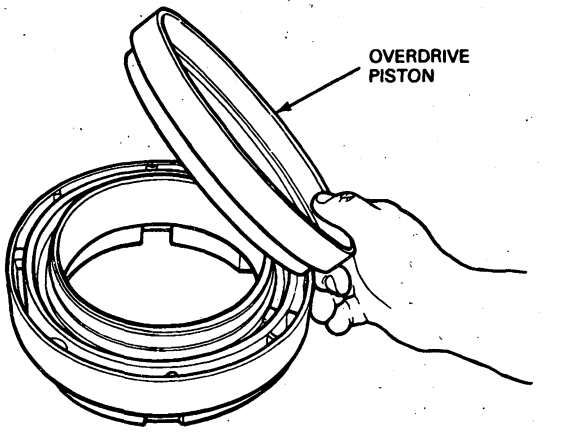
4. Install overdrive outer and inner seals with lip seal facing down towards cylinder.



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DISASSEMBLY AND ASSEMBLY (Continued)

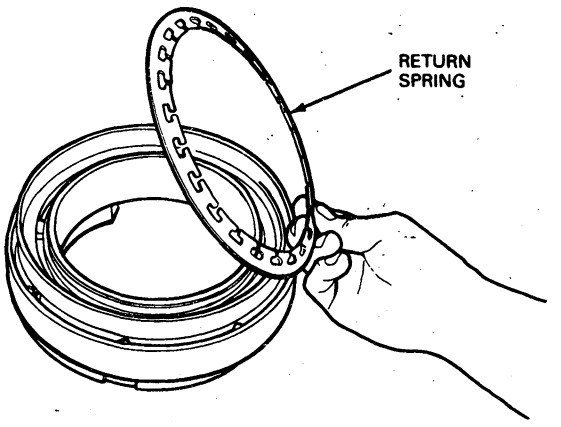
5. Install overdrive piston.



D9081-1A

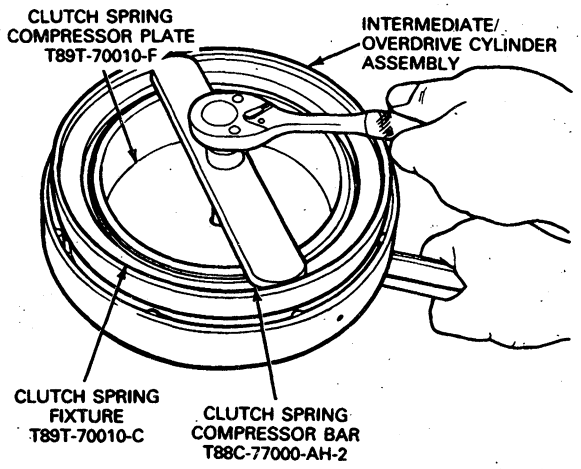
6. Install return spring.

NOTE: Spring fingers facing up.



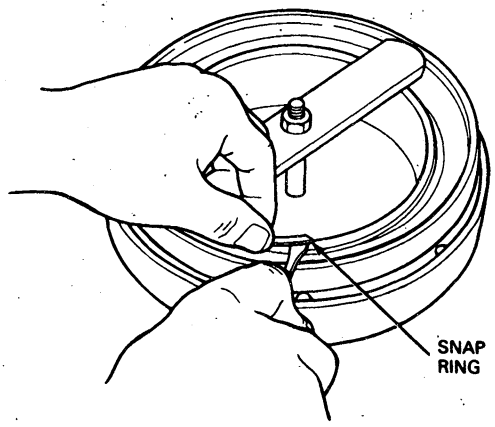
D9080-1A

7. Using Clutch Spring Compressor Plate T89T-70010-F Clutch Spring Compressor Bar T88C-77000-AH2 and Intermediate Clutch Spring Fixture T89T-70010-C or equivalents, compress return spring.



D9078-1A

8. Install snap ring.



D9079-1A

9. Remove tool assembly.

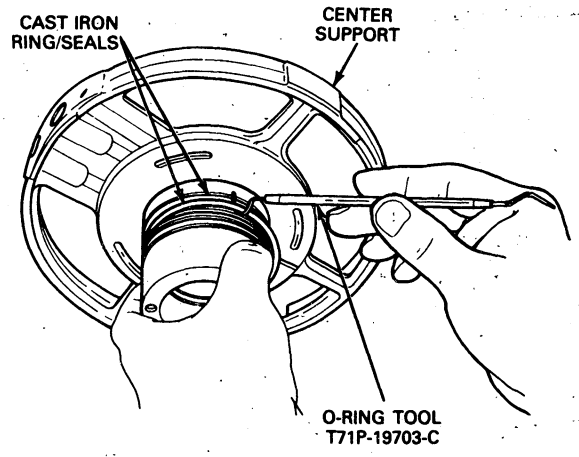
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DISASSEMBLY AND ASSEMBLY (Continued)

Center Support

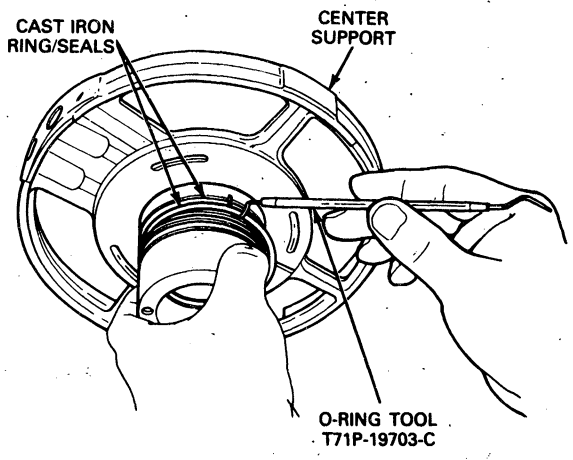
Disassembly

1. Remove two cast iron outer seal rings.



Assembly

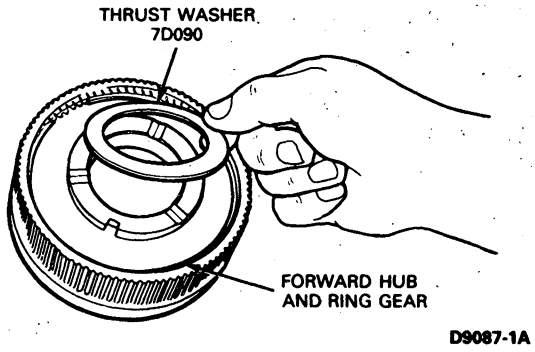
1. Install two cast iron seal rings.



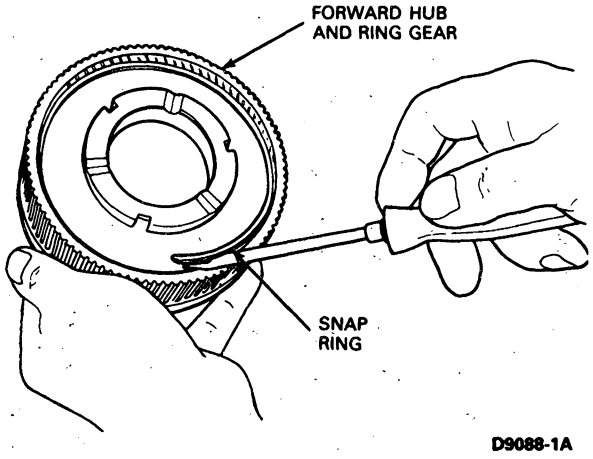
Forward Hub and Ring Gear

Disassembly

1. Remove plastic thrust washer No. 7D090 from front face of hub.



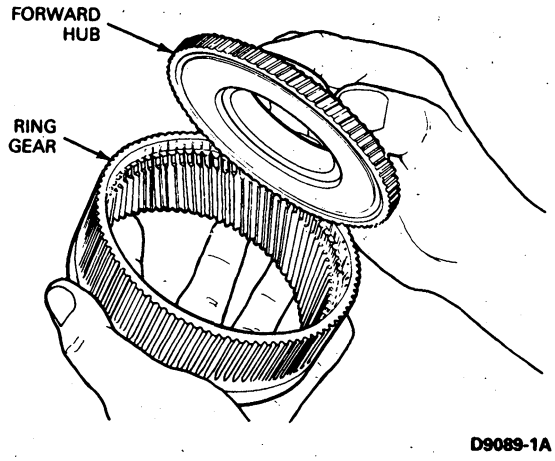
2. Remove snap ring using screwdriver.



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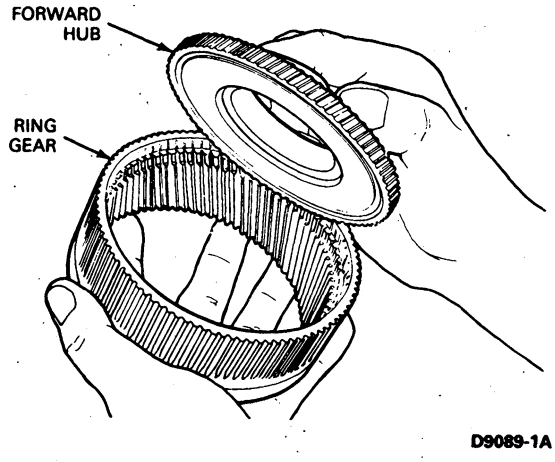
DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove forward hub from ring gear.

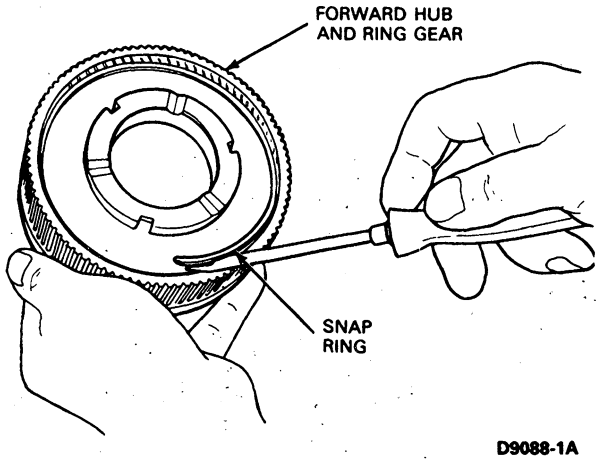


Assembly

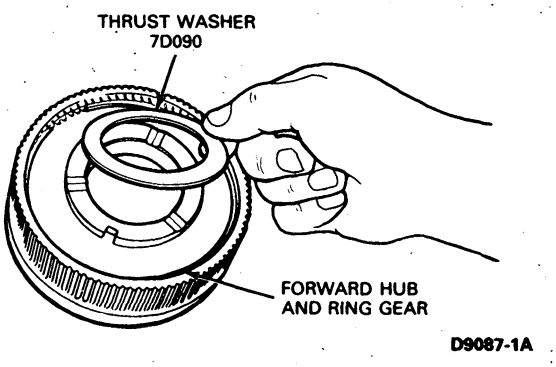
1. Install forward hub into gear.



2. Install snap ring.



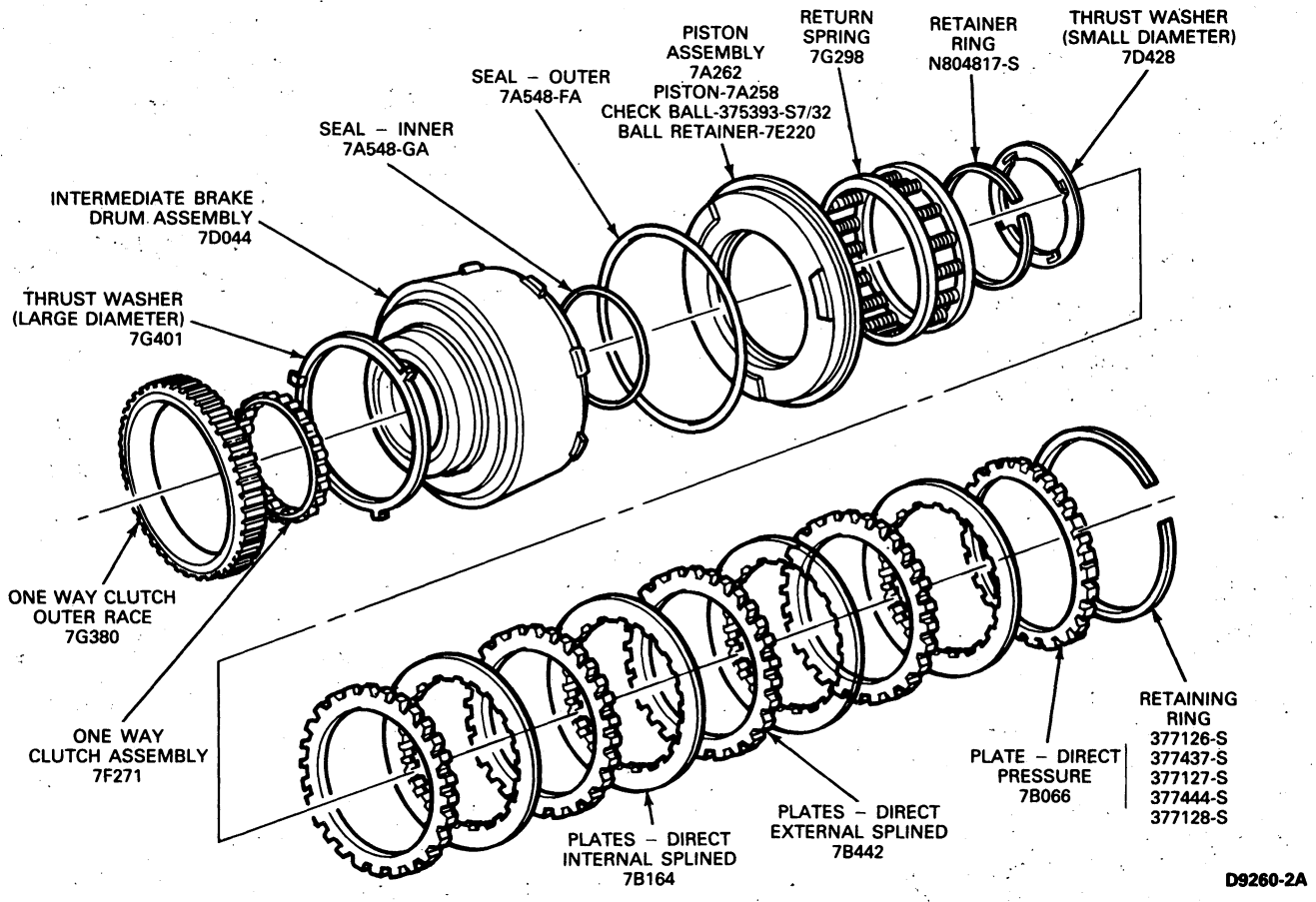
3. Install plastic thrust washer No. 7D090 on the hub, using grease.



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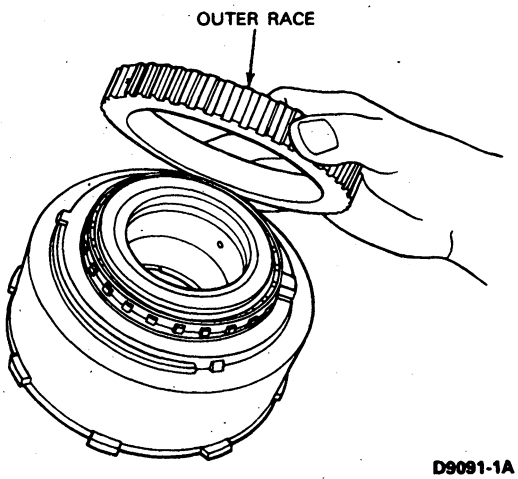
DISASSEMBLY AND ASSEMBLY (Continued)

Intermediate Brake Drum

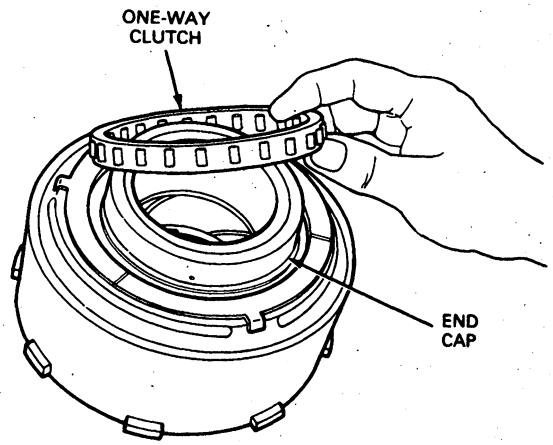


Disassembly

1. Remove outer race.

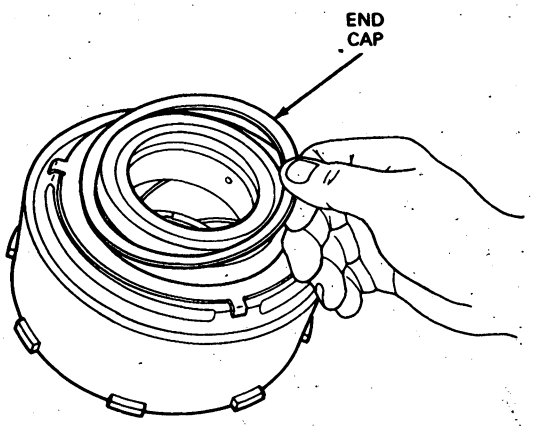


2. Remove one-way clutch assembly and end caps.

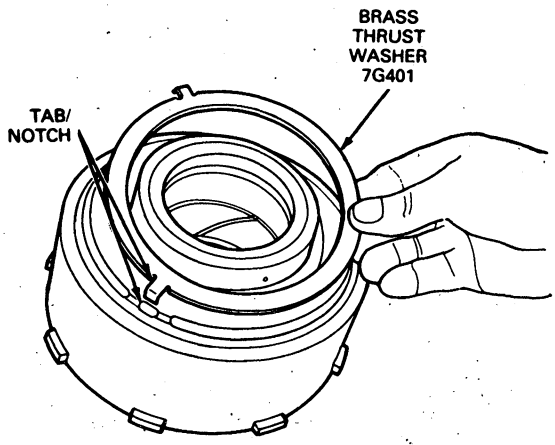


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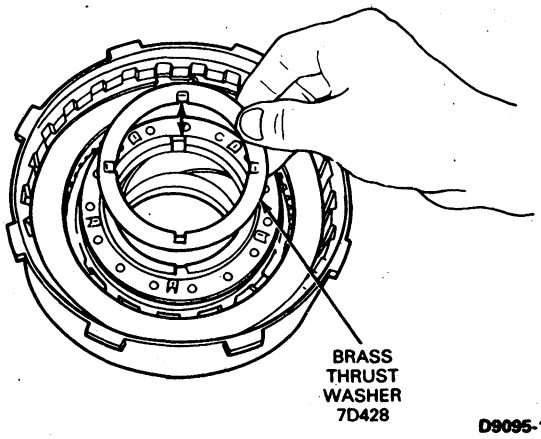
DISASSEMBLY AND ASSEMBLY (Continued)



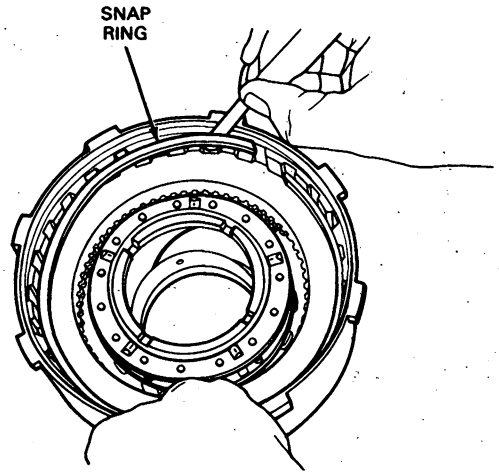
3. Remove large brass thrust washer No. 7G401 from rear face of cylinder.



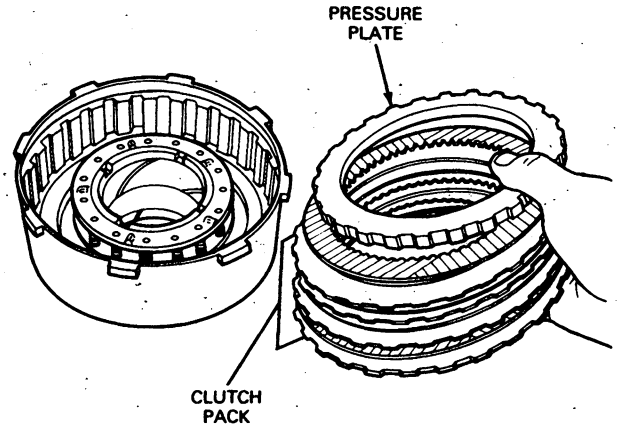
4. Remove small brass thrust washer No. 7D428 from front face of cylinder.



5. Remove snap ring using screwdriver.



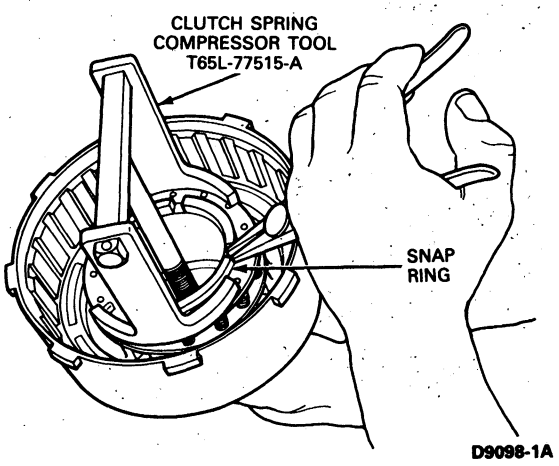
6. Remove pressure plate and clutch pack. Tag for re-assembly.



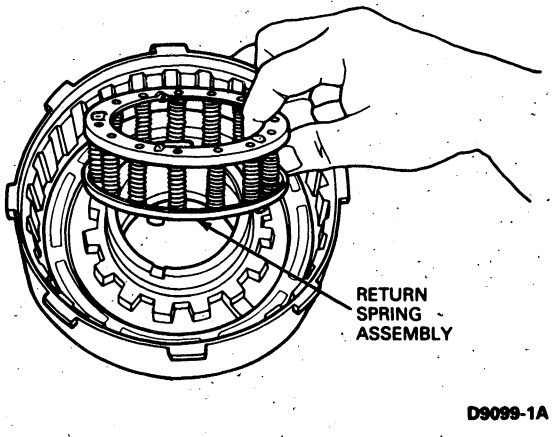
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DISASSEMBLY AND ASSEMBLY (Continued)

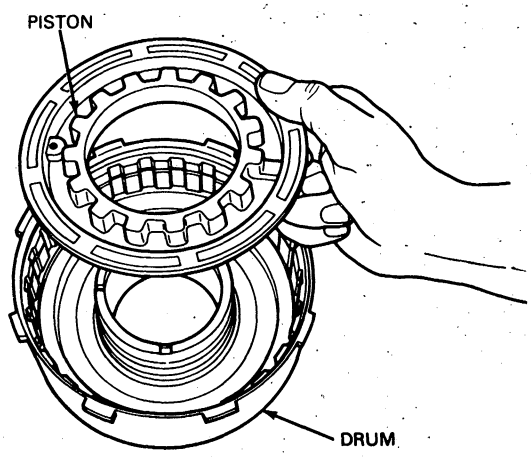
7. Install Clutch Spring Compressor Tool T65L-77515-A or equivalent and remove return spring snap ring.



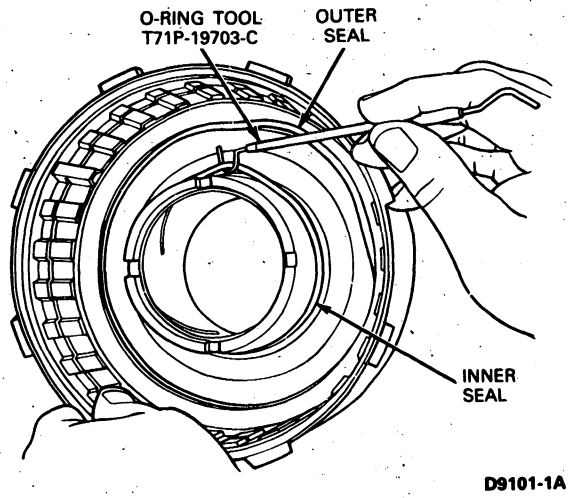
8. Remove return spring assembly.



9. Remove piston from intermediate brake drum.



10. Remove inner and outer seals from drum using O-Ring Tool T71P-19703-C or equivalent.

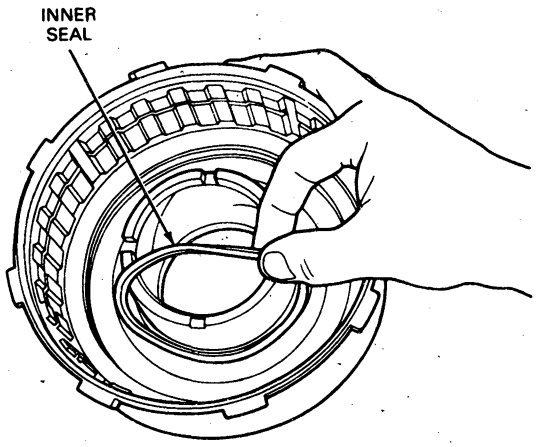


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DISASSEMBLY AND ASSEMBLY (Continued)

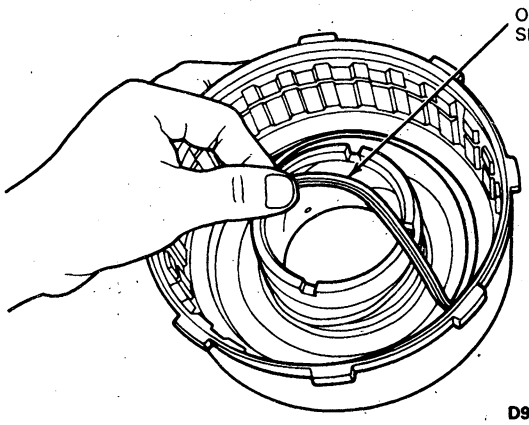
Assembly

1. Install inner seal into cylinder with seal groove facing down.



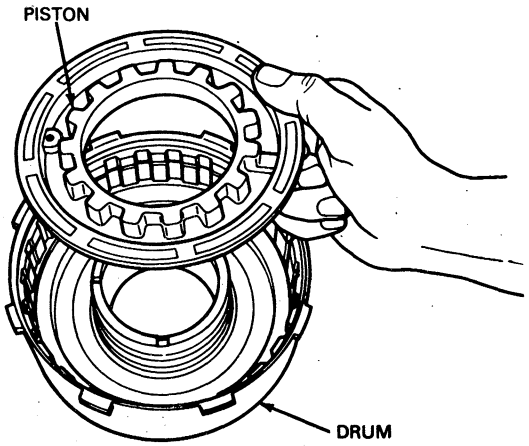
D9103-1A

2. Install outer seal into intermediate brake drum with seal groove facing down.



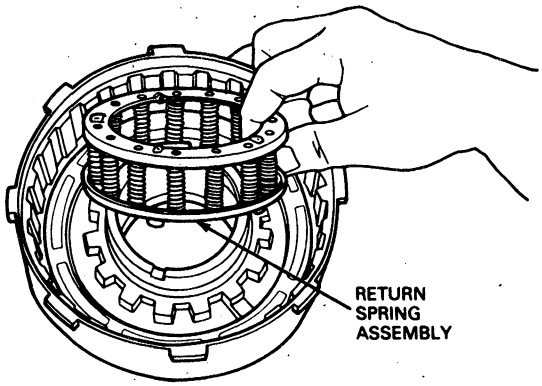
D9102-1A

3. Inspect piston check ball for freedom of movement. Clean with solvent if necessary.
4. Install piston into drum.



D9100-1A

5. Install return spring assembly.

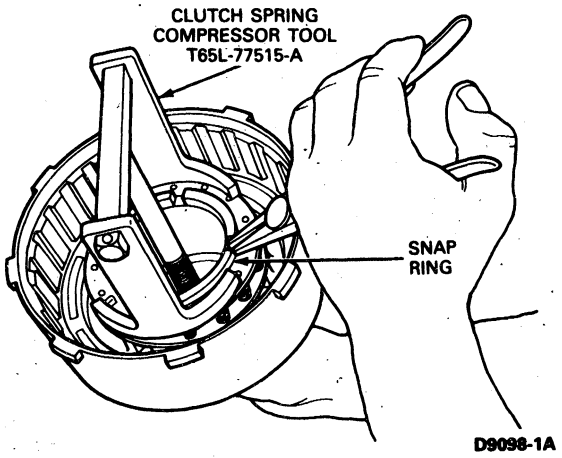


D9099-1A

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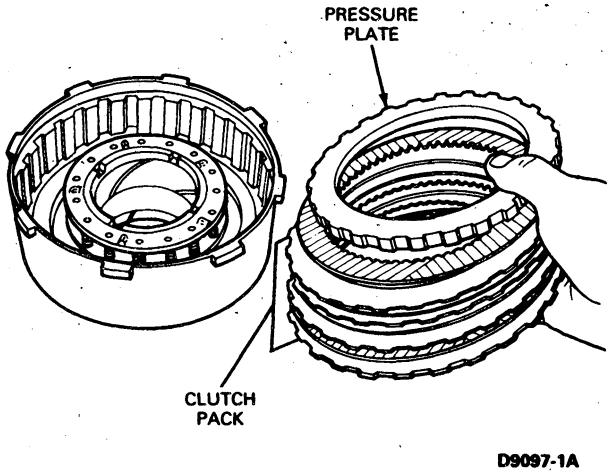
DISASSEMBLY AND ASSEMBLY (Continued)

6. Install return spring assembly. Using Clutch Spring Compressor Tool T65L-77515-A or equivalent. Install snap ring. Ensure protrusions on spring retainer are properly engaged with lugs on clutch piston.



7. Install four plate clutch pack, starting with steel plate. Install pressure plate.

NOTE: Soak the clutch plates with clean transmission fluid (Ford Specification Mercon® ESA-M2C1166-H) or equivalent for fifteen minutes.



8. Install selective snap ring. Check stack-up using feeler gauge. If not within specification, install correct snap ring and recheck.

Specification:

1.52 - 1.15mm (0.060 - 0.045 inch)

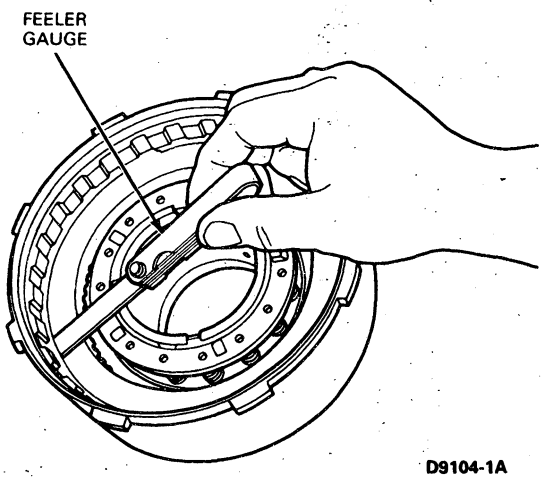
Selective Snap Rings:

Selective Snap Rings

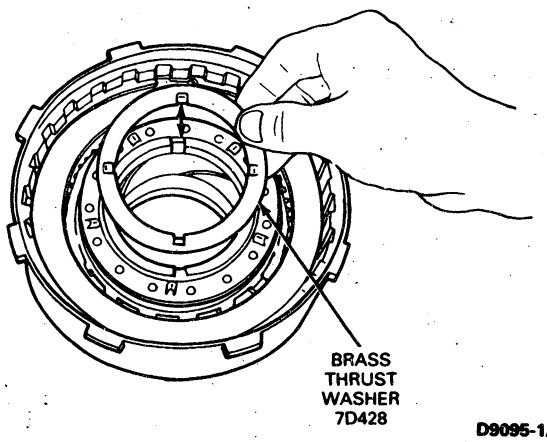
1.65 - 1.75mm (0.065 - 0.069 inch)

1.88 - 1.98mm (0.074 - 0.078 inch)

2.10 - 2.20mm (0.083 - 0.087 inch)



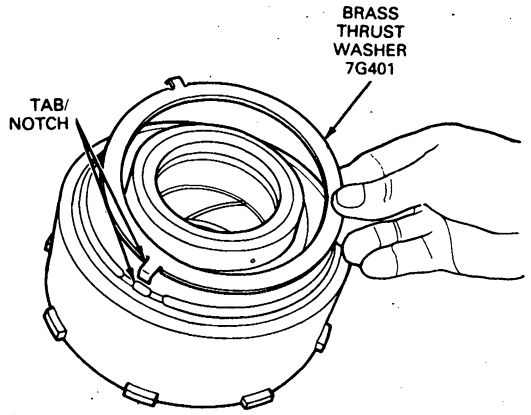
9. Install small brass thrust washer No. 7D428 on face of cylinder.



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DISASSEMBLY AND ASSEMBLY (Continued)

10. Install large brass thrust washer No. 7G401 on face of cylinder.

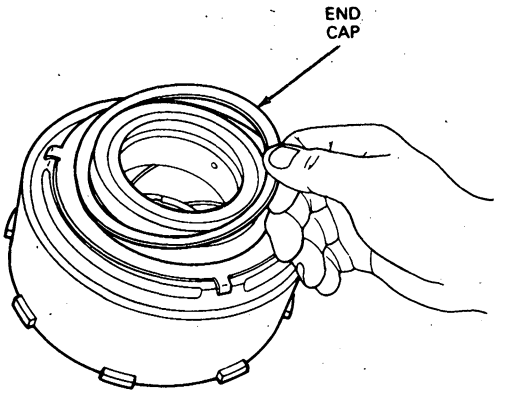


D9094-1A

11. Install intermediate one-way clutch end cap, one-way clutch assembly, outer race, and outer end cap over inner race.

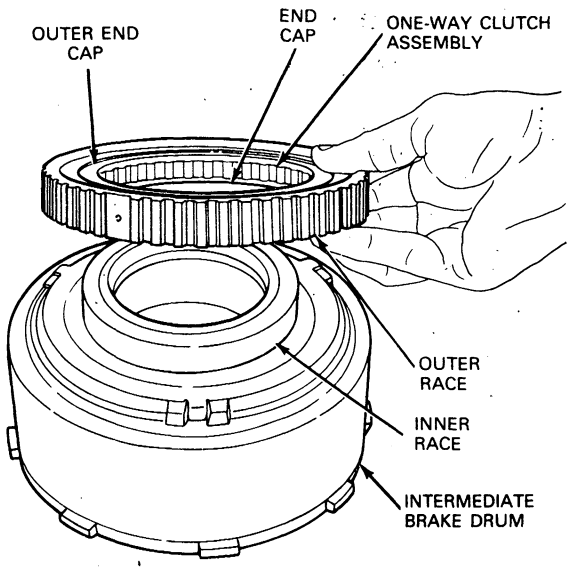
NOTE: Lip is up on one-way clutch.

NOTE: Install onto inner race so that the outer race turns counterclockwise.



D9093-1A

12. Install outer race so that the race turns counterclockwise.



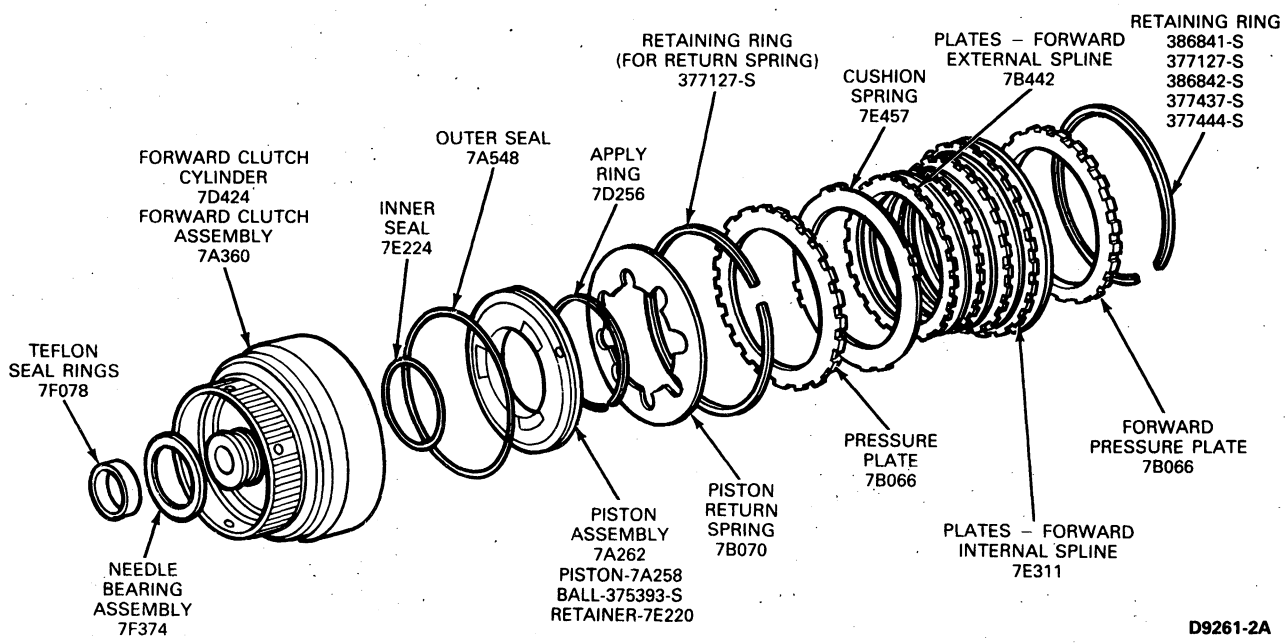
D9281-1A

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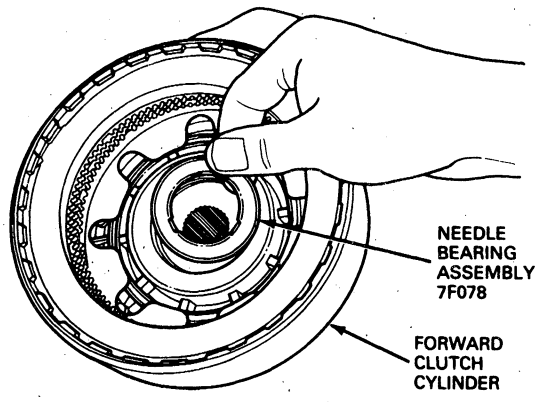
DISASSEMBLY AND ASSEMBLY (Continued)

Forward Clutch Assembly

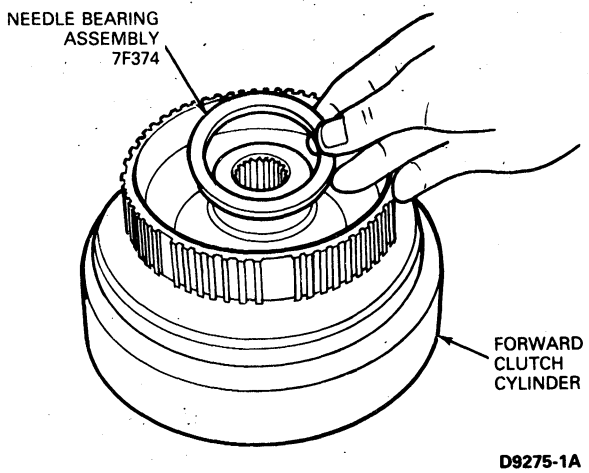
Disassembly



1. Remove needle bearing assembly from inner face of cylinder.

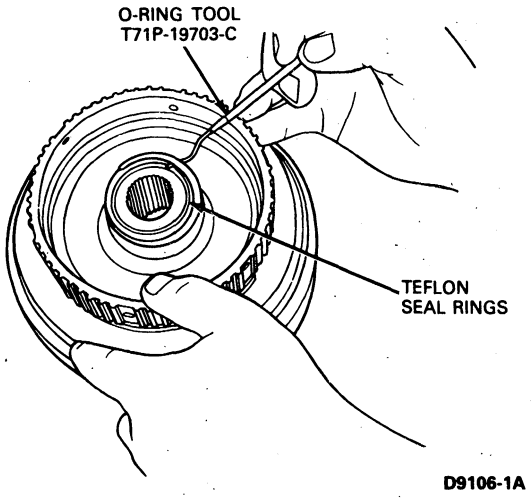


2. Remove needle bearing assembly No. 7F374.
3. Remove both teflon seal/rings from grooves using O-Ring Tool T71P-19703-C or equivalent.

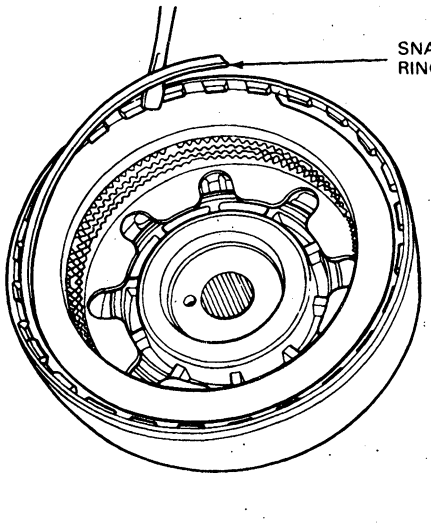


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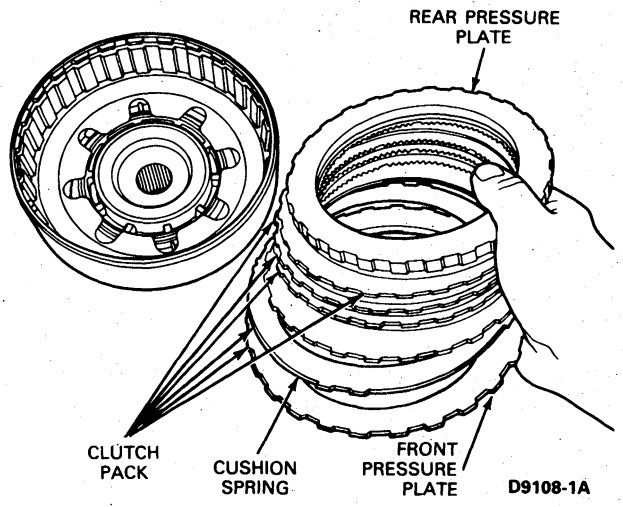
DISASSEMBLY AND ASSEMBLY (Continued)



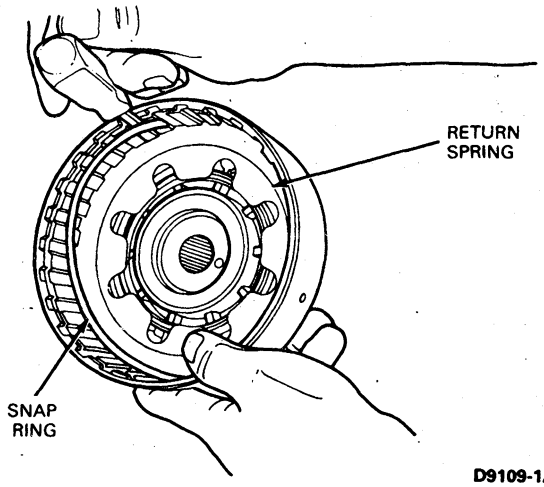
4. Remove snap ring.



5. Remove rear pressure plate.
6. Remove four plate clutch pack, cushion spring and front pressure plate. Tag for re-assembly.



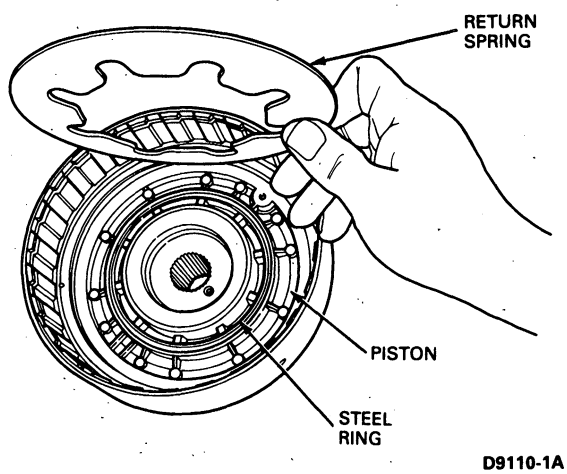
7. Remove return spring snap ring.



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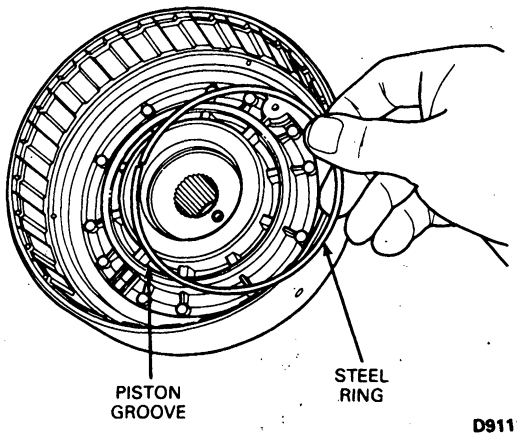
DISASSEMBLY AND ASSEMBLY (Continued)

8. Remove return spring.



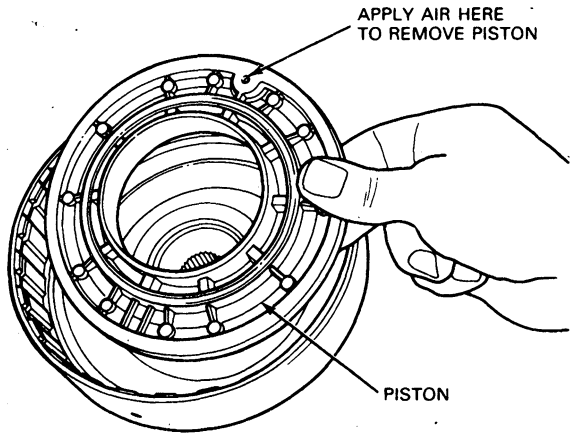
D9110-1A

9. Remove steel ring from piston groove.



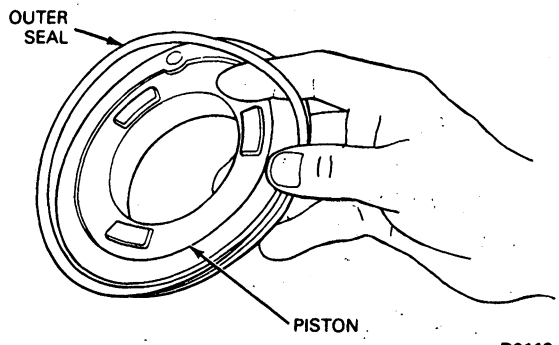
D9111-1A

10. Remove piston from cylinder using an air nozzle.



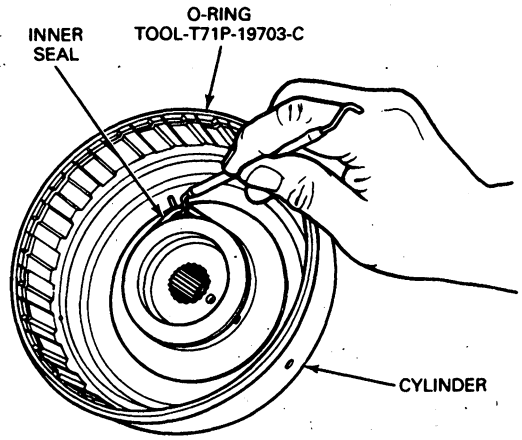
D9112-1A

11. Remove outer seal from piston.



D9113-1A

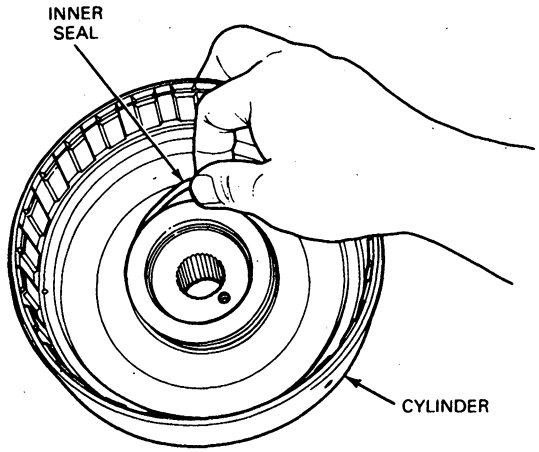
12. Remove inner seal from the cylinder.



D9114-1A

Assembly

1. Install inner seal in cylinder.

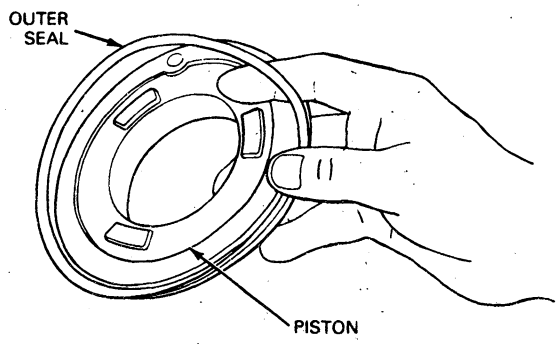


D9115-1A

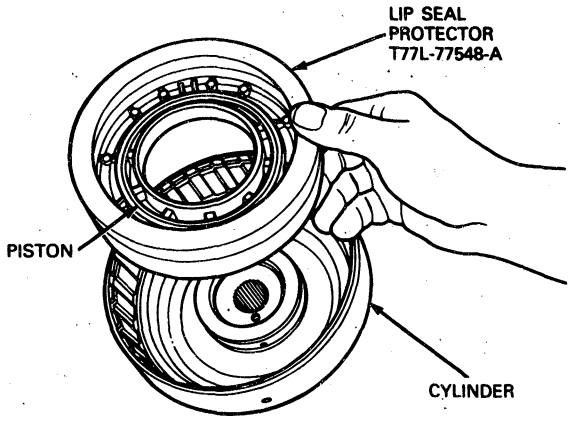
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DISASSEMBLY AND ASSEMBLY (Continued)

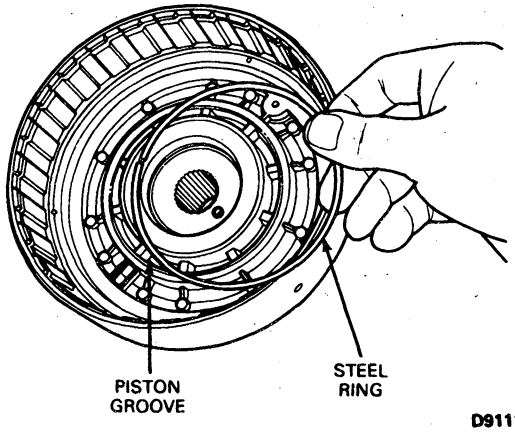
2. Install outer seal on piston.



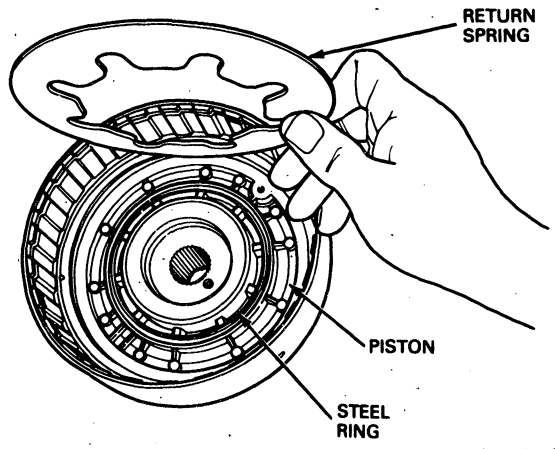
3. Inspect piston check ball for freedom of movement. Clean with solvent if necessary.
4. Install piston into cylinder using Lip Seal Protector T77L-77548-A or equivalent.



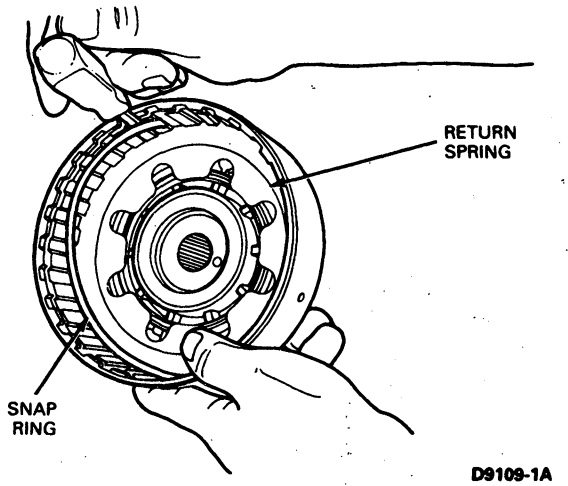
5. Install steel ring into groove on piston.



6. Install return spring with the return spring fingers against the piston/steel ring.



7. Install snap ring.



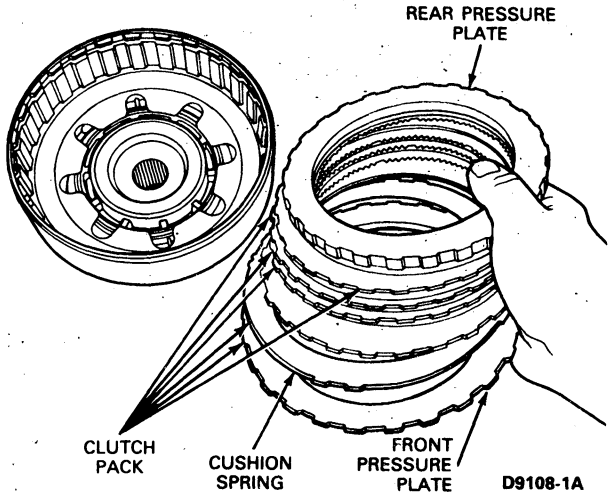
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DISASSEMBLY AND ASSEMBLY (Continued)

8. Install front pressure plate.
9. Install cushion spring.
10. Install four steel plates and four friction plates alternately, starting with a steel plate.

NOTE: Soak the clutch plates with clean transmission fluid (Ford Specification Mercon® ESP-M2C1166-H) or equivalent for fifteen minutes.

11. Install rear pressure plate.



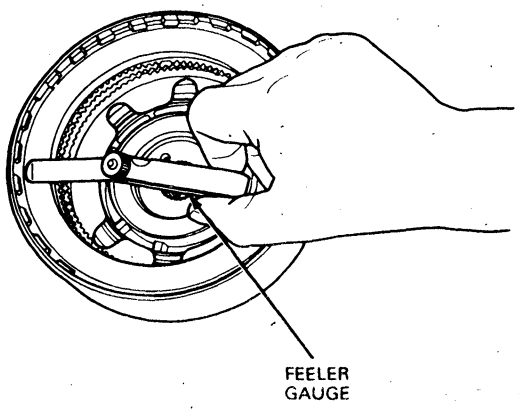
12. Install selective snap ring.
13. Check stack-up clearance, using feeler gauge. If not within specification install correct snap ring and recheck.

Stack Up Clearance Specification:

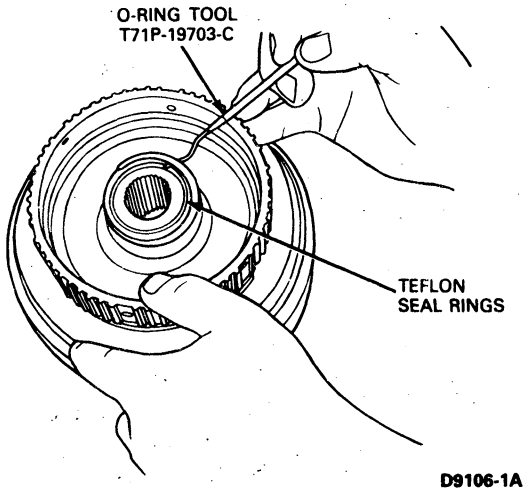
1.40 - 0.76mm (0.055 - 0.030 inch)

Selective Snap Rings:

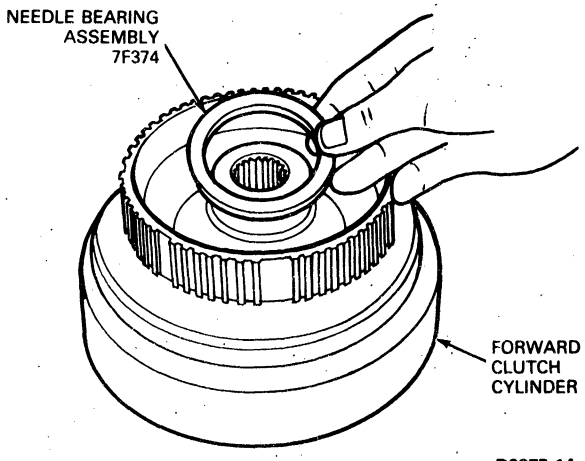
1.42 - 1.52mm (0.056 - 0.060 inch)
1.88 - 1.98mm (0.074 - 0.078 inch)
2.34 - 2.44mm (0.092 - 0.096 inch)
2.79 - 2.90mm (0.110 - 0.114 inch)
3.25 - 3.35mm (0.128 - 0.132 inch)



14. Install Teflon® seal rings in grooves.



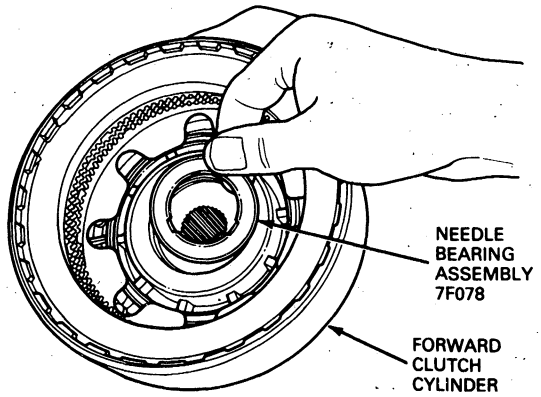
15. Install needle bearing assembly no. 75374 over Teflon® seal snout.



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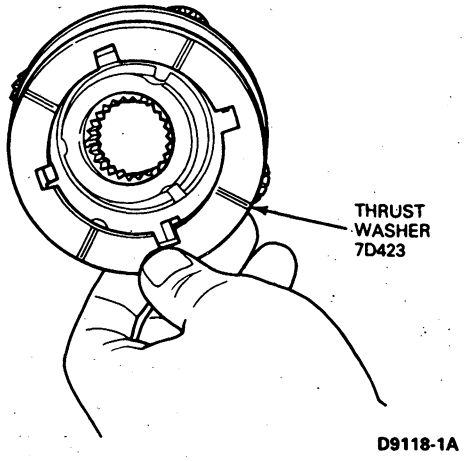
DISASSEMBLY AND ASSEMBLY (Continued)

16. Install needle bearing assembly on inner face of cylinder, with notched inner race facing outward.



D9105-1A

2. Remove thrust washer No. 7D423 from front side of carrier.

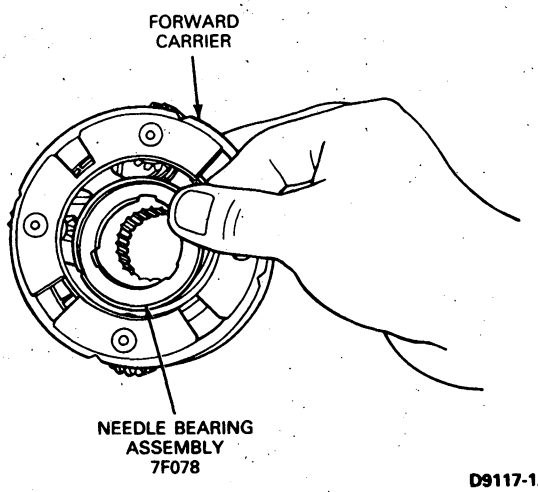


D9118-1A

Forward Carrier

Disassembly

1. Remove needle bearing assembly No. 7F078 from carrier.

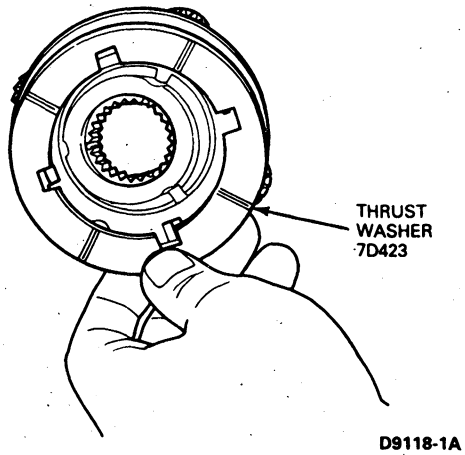


D9117-1A

Assembly

1. Place thrust washer No. 7D423 on front side of carrier, using grease to hold in place.

NOTE: Thrust washer tabs go into carrier.



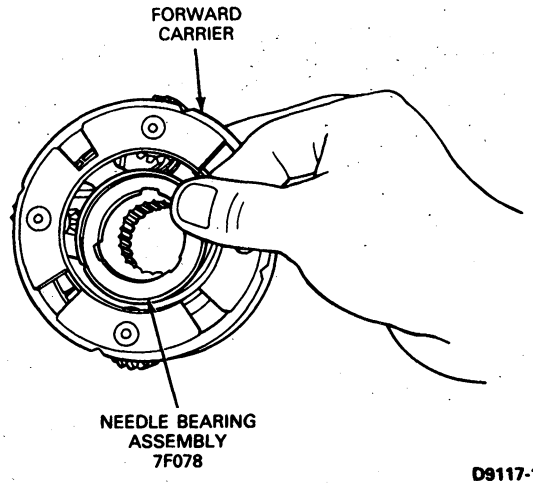
D9118-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

2. Install needle bearing assembly on inner face of carrier.

NOTE: Install notched inner race facing outward.

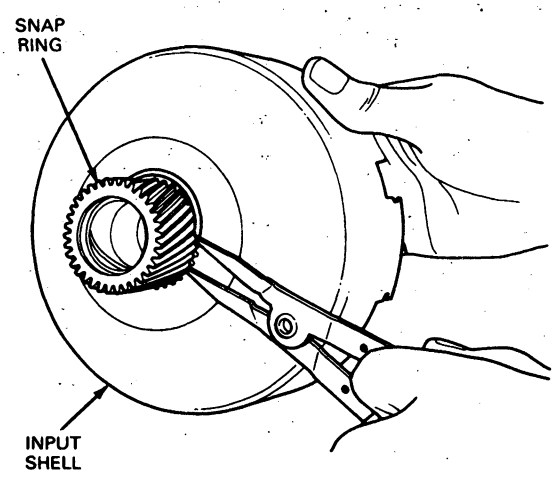


D9117-1A

Input Shell

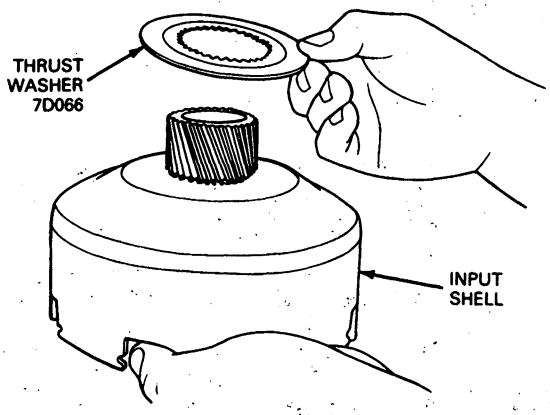
Disassembly

1. Remove snap ring from reverse sun gear using snap ring pliers.



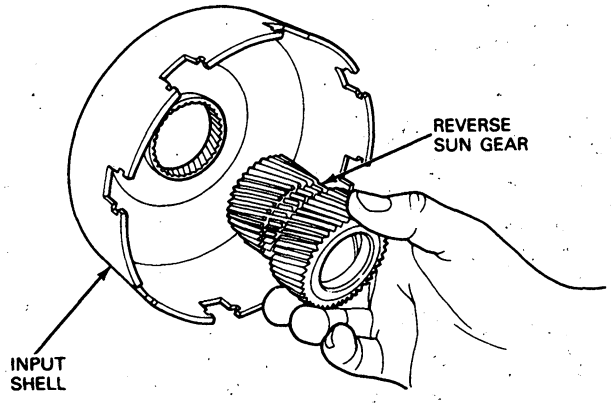
D9119-1A

2. Remove thrust washer No. 7D066 from input shell.



D9120-1A

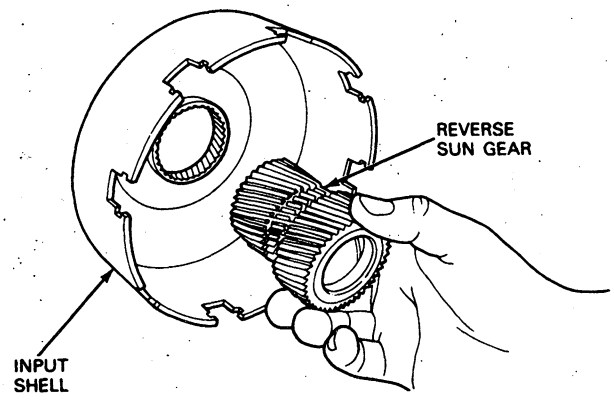
3. Remove reverse sun gear from input shell.



D9121-1A

Assembly

1. Install reverse sun gear into input shell so that lube hole in sun gear is between stand-off pads on shell.

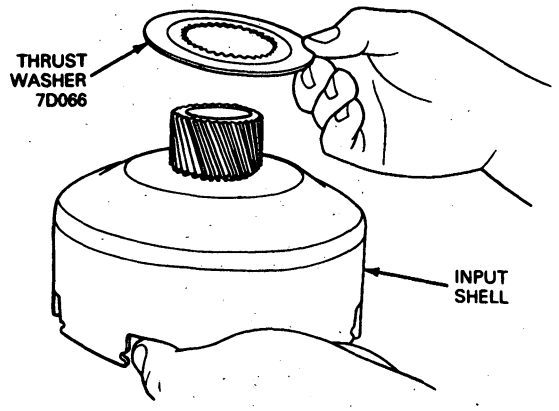


D9121-1A

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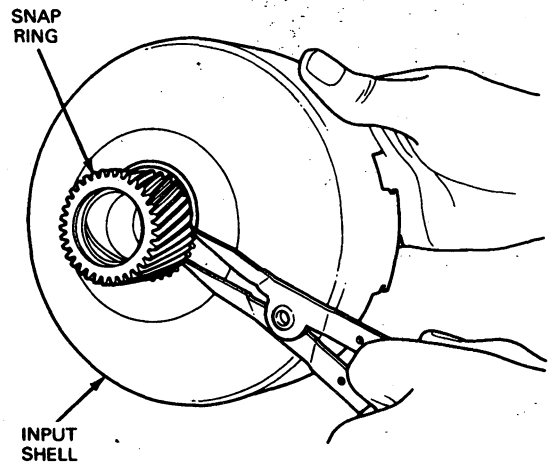
DISASSEMBLY AND ASSEMBLY (Continued)

2. Install input shell thrust washer No. 7D066 onto reverse sun gear.



D9120-1A

3. Install snap ring onto reverse sun gear using snap ring pliers.

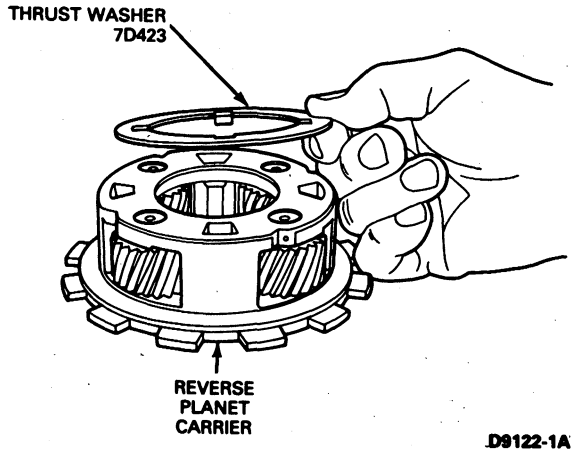


D9119-1A

Reverse Planet Carrier

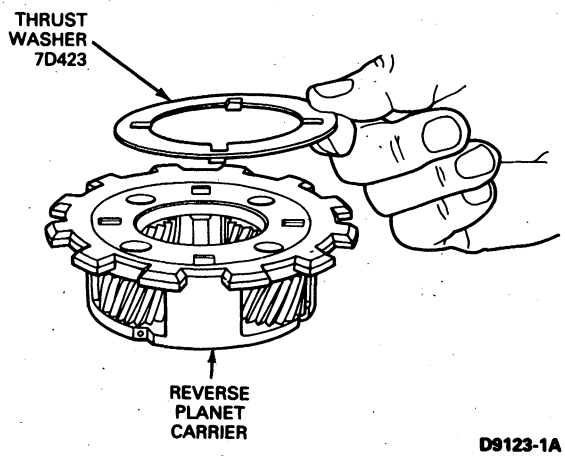
Disassembly

1. Remove rear thrust washer No. 7D423.



D9122-1A

2. Remove front thrust washer No. 7D423.



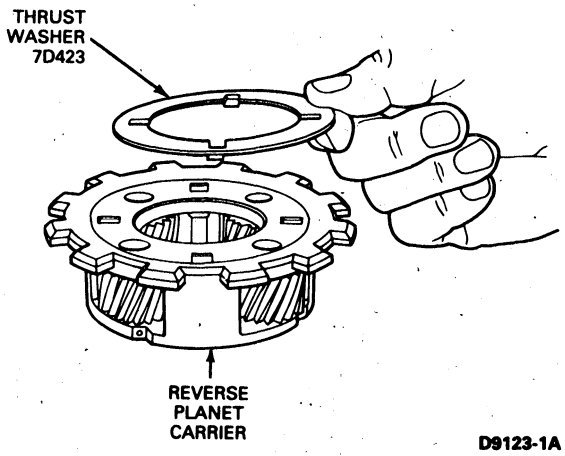
D9123-1A

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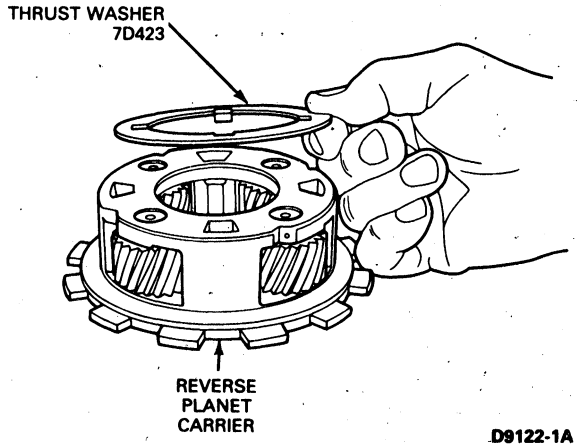
DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

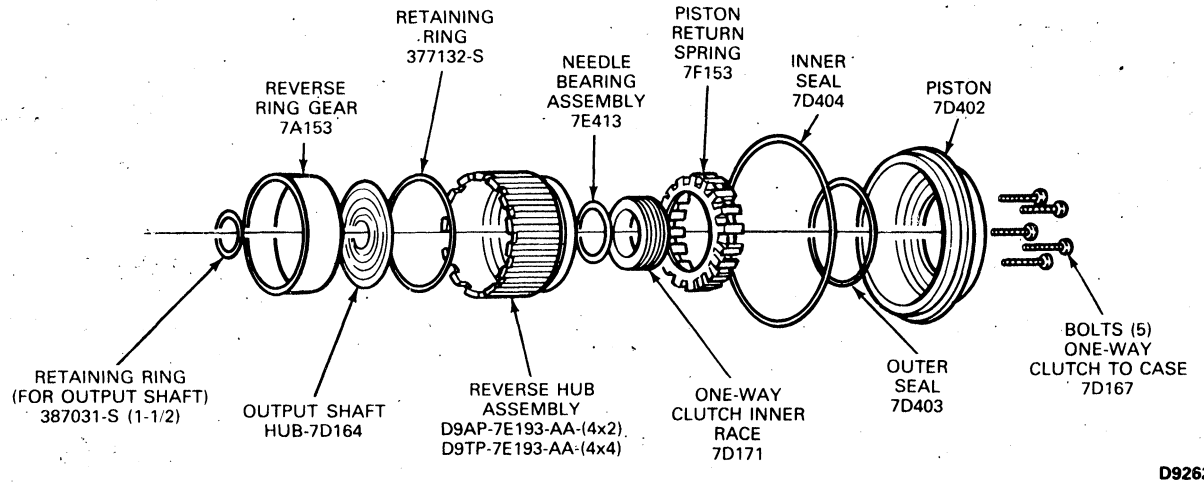
1. Install front thrust washer No. 7D423. Hold in place using grease.



2. Install rear thrust washer No. 7D423. Hold in place using grease.



Reverse One-Way Clutch

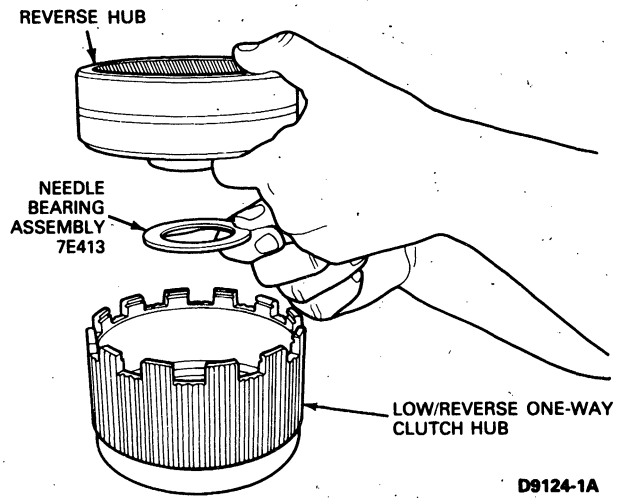


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DISASSEMBLY AND ASSEMBLY (Continued)

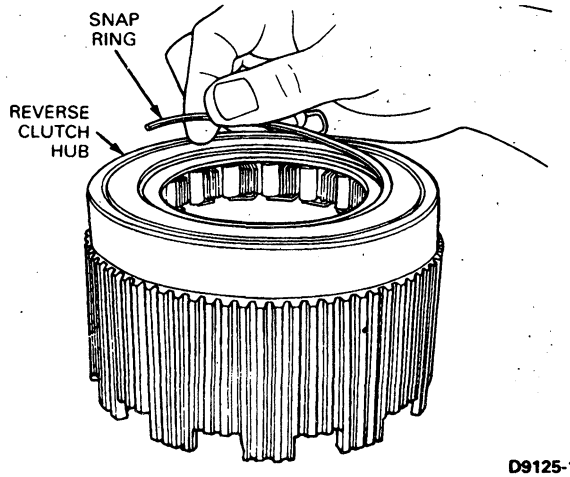
Disassembly

1. Remove reverse hub and needle bearing assembly No. 7E413 from reverse one-way clutch hub.



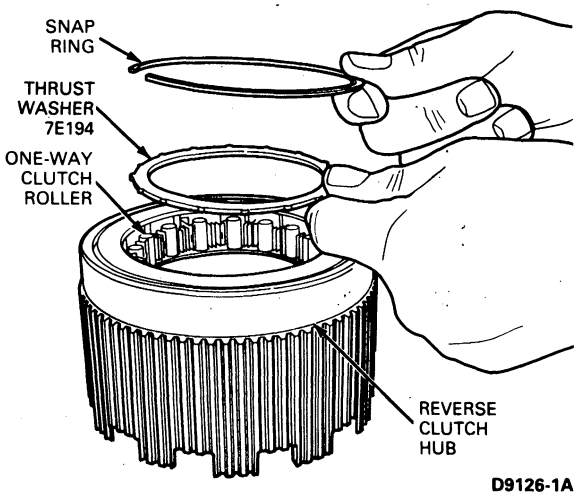
D9124-1A

2. Remove snap ring from reverse one-way clutch hub.



D9125-1A

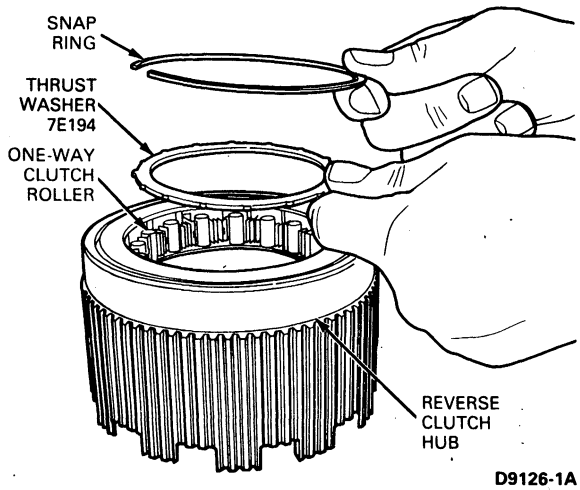
3. Remove brass thrust washer and rollers from reverse clutch hub.



D9126-1A

Assembly

1. Install one-way clutch rollers and brass thrust washer No. 7E194.

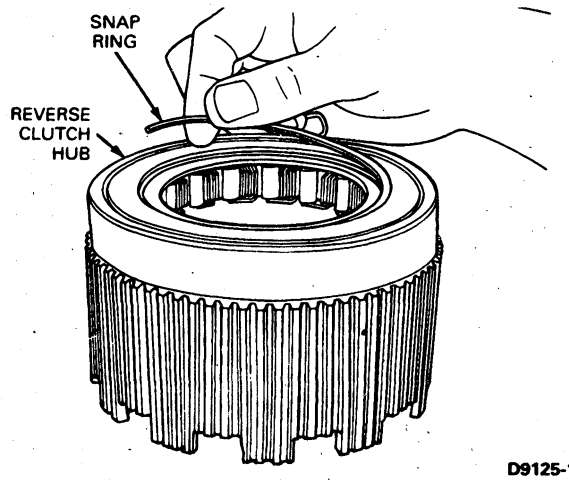


D9126-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

2. Install snap ring onto one-way clutch hub.



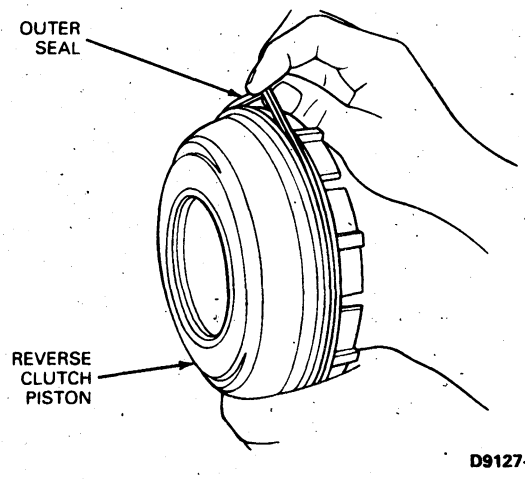
3. Install needle bearing assembly No. 7E413 with smooth race surface facing up.

NOTE: Lightly grease thrust washer.

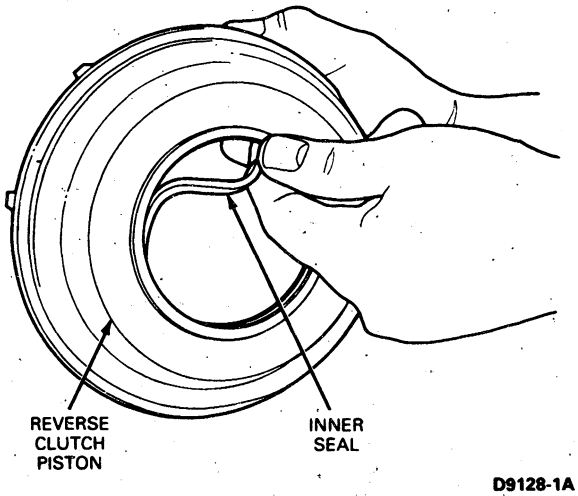
Reverse Clutch Piston

Disassembly

1. Remove outer piston seal.

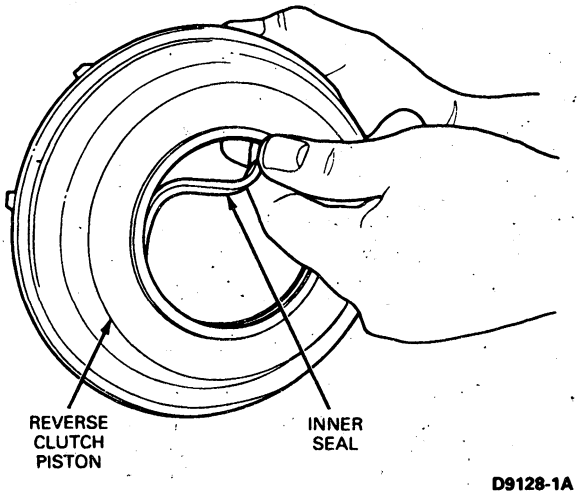


2. Remove inner piston seal.



Assembly

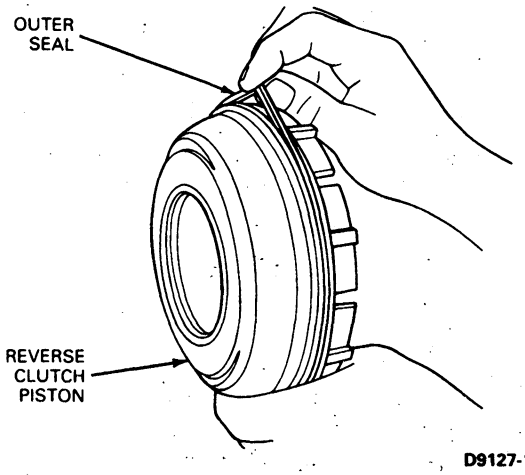
1. Install inner piston seal.



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DISASSEMBLY AND ASSEMBLY (Continued)

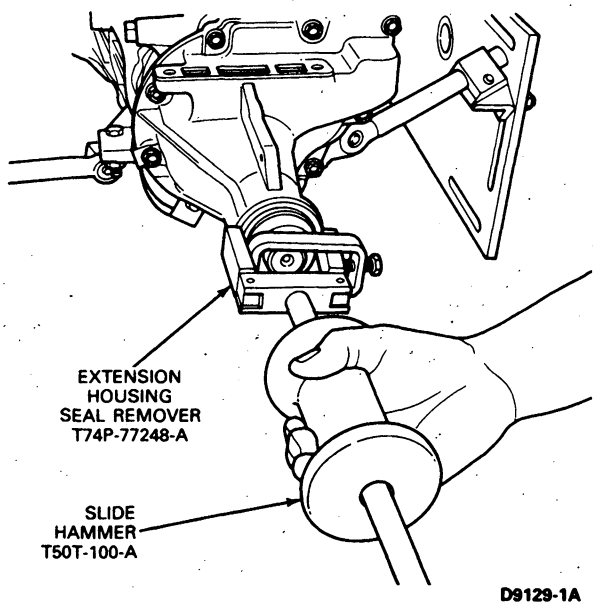
2. Install outer piston seal.



Extension Housing

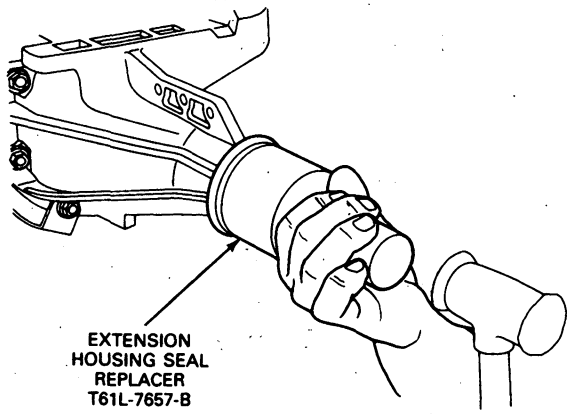
Disassembly

1. Using Extension Housing Seal Remover T74P-77248-A and Slide Hammer T50T-100-A or equivalents, remove seal.



Assembly

1. Install extension housing seal, using Extension Housing Seal Replacer T61L-7657-B or equivalent.

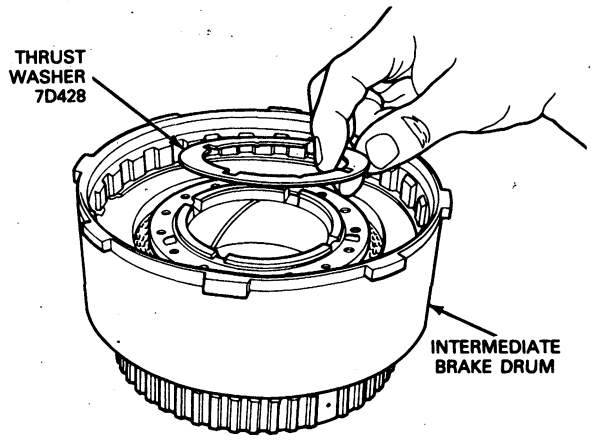


ASSEMBLY OF SUBASSEMBLIES

Assembly

1. Place thrust washer No. 7D428 onto intermediate brake drum.

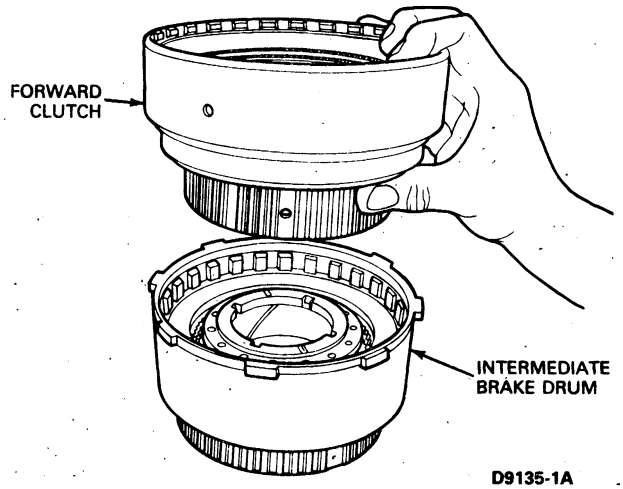
NOTE: Lightly grease thrust washer.

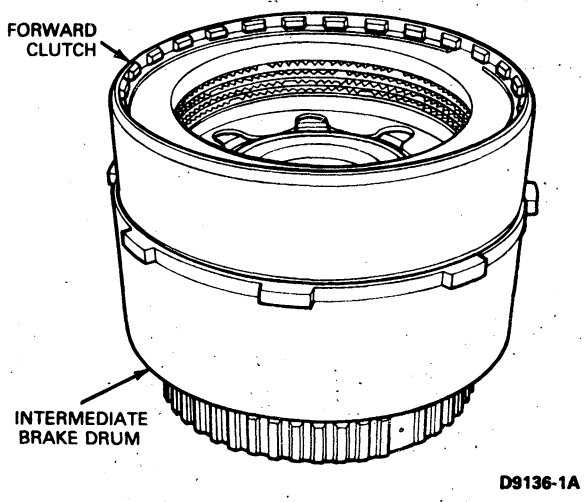


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ASSEMBLY OF SUBASSEMBLIES (Continued)

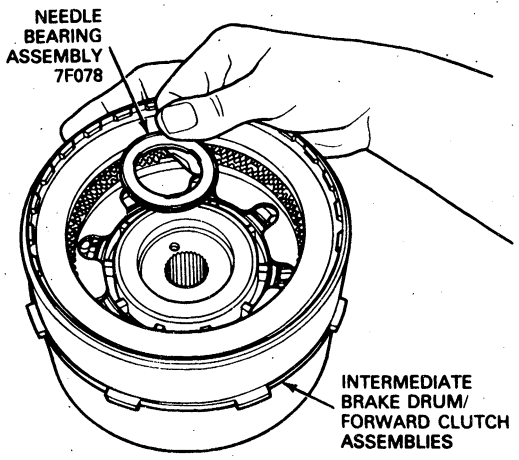
2. Install forward clutch onto intermediate brake drum.



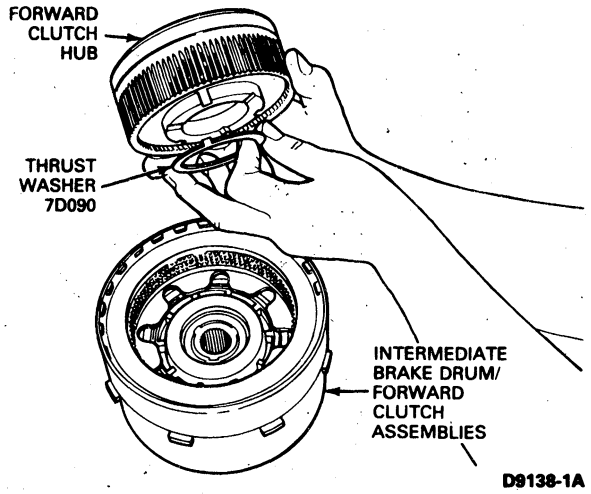


3. Install needle bearing assembly 7F078 onto intermediate brake drum and forward clutch assembly.

NOTE: Lightly grease needle bearing assembly. Notched inner race facing outward (up).

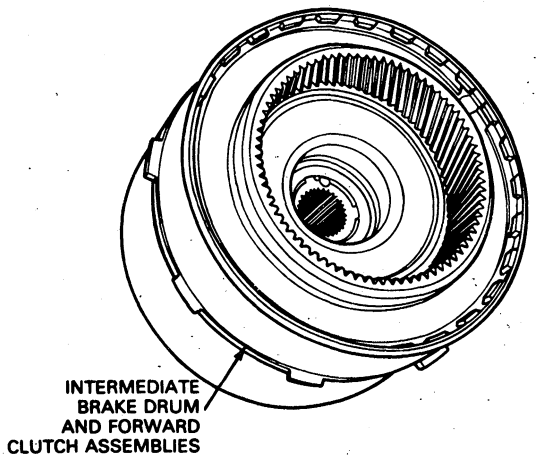


4. Grease plastic thrust washer No. 7D090 and place onto forward clutch hub. Place forward clutch hub into intermediate brake drum and forward clutch assemblies.

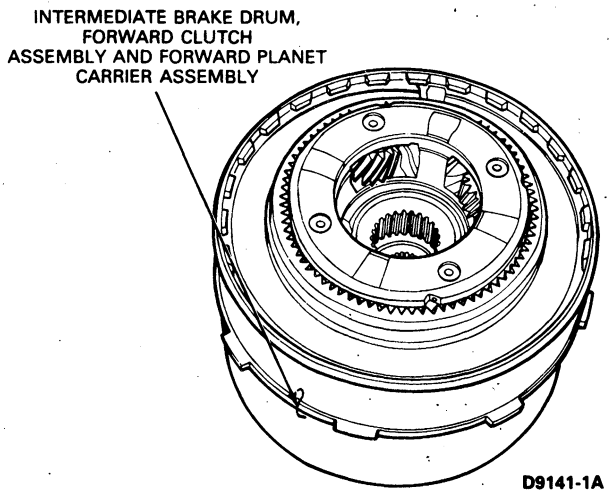


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ASSEMBLY OF SUBASSEMBLIES (Continued)

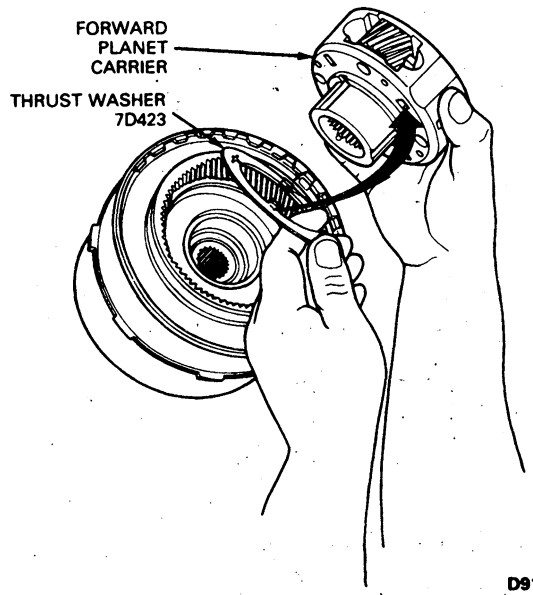


D9139-1A



D9141-1A

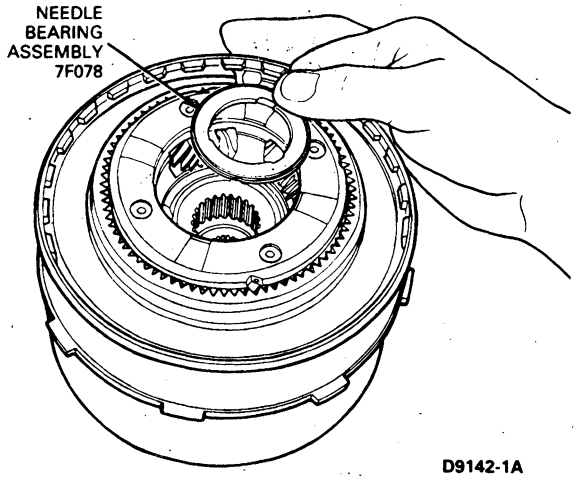
5. Grease thrust washer No. 7D423 and place onto forward planet carrier. Place carrier into assembly.



D9140-1A

6. Install needle bearing assembly No. 7F078 into forward carrier assembly.

NOTE: Lightly grease needle bearing to hold in place. Notched inner race surface should face up.

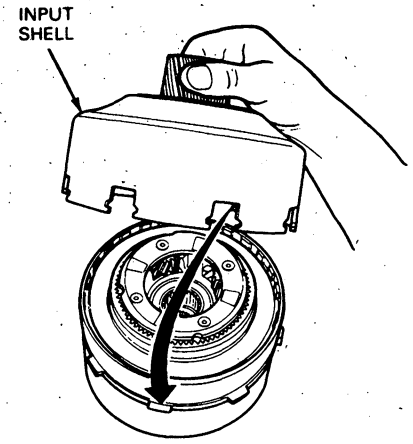


D9142-1A

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ASSEMBLY OF SUBASSEMBLIES (Continued)

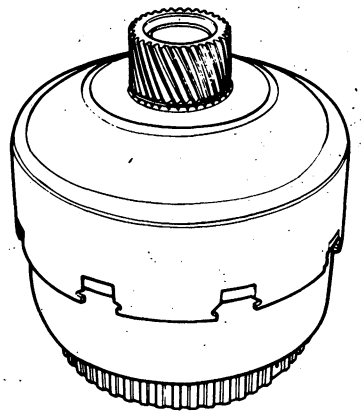
7. Align input shell notches with intermediate brake drum.



D9143-1A

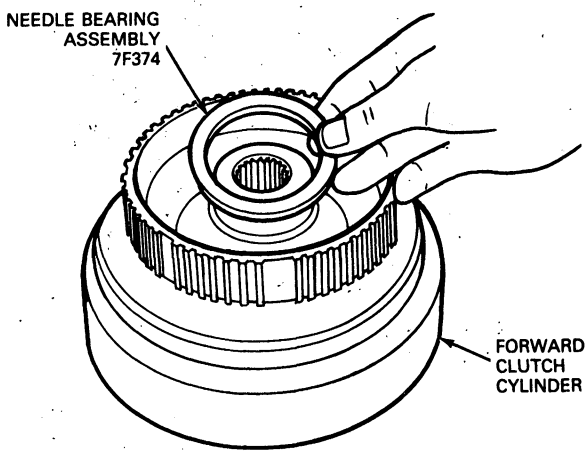
8. Install input shell onto assembly.

INTERMEDIATE BRAKE DRUM, FORWARD CLUTCH AND INPUT SHELL ASSEMBLY



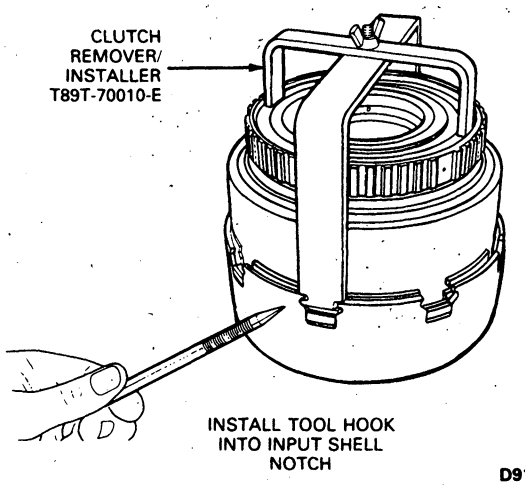
D9144-1A

9. Install needle bearing assembly No. 7F374 into front end of forward clutch assembly.



D9275-1A

10. Install Intermediate Brake Drum, Forward Clutch and Input Shell Remover/Install T89T-70010-E or equivalent and proceed with transmission assembly.



D9145-1A

CLEANING AND INSPECTION

Transmission

Clean all parts with suitable solvent and use moisture-free air to dry off all parts and clean out fluid passages.

The composition clutch plates, bands and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution. To clean these parts, wipe them off with a lint- free cloth. New clutch plates or bands should be soaked in the specified transmission fluid for 15 minutes before being assembled.

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CLEANING AND INSPECTION (Continued)

Valve Bodies

1. Clean all parts, except non-metallic check balls, thoroughly in clean solvent, and blow dry with moisture-free compressed air.
2. Inspect all valve and plunger bores for scores. Check all fluid passages for obstructions. Inspect all mating surfaces for burrs and scores. **If necessary, use crocus cloth to polish valves and plungers. Avoid rounding the sharp edges of the valves and plungers with the crocus cloth.**
3. Inspect all springs for distortion. Check all valves and plungers for free movement in their respective bores. Valves and plungers, when dry, must fall from their own weight in their respective bores.
4. Roll the manual valve on a flat surface to check for bent condition.

Forward, Direct, Intermediate, Overdrive, Coast and Reverse Clutches

1. Inspect the clutch cylinder thrust surfaces, piston bore, and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the check balls for freedom of movement and proper seating.
3. Check the clutch release spring for distortion and cracks. Replace the spring (including wave spring) if it is distorted or cracked.
4. Inspect the composition clutch plates, steel clutch plates, and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored or burred.
5. Check the clutch plates for flatness and fit on the clutch hub serrations. Discard any plate that does not slide freely on the serrations or that is not flat.
6. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.

Output Shaft

1. Inspect the output shaft bearing surfaces for scores. If excessive clearance or scores are found, replace shaft and inspect components.
2. Check the splines on the output shaft for wear, replace the shaft if the splines are excessively worn. Inspect all the bushings.

One-Way Clutches

1. Inspect the outer and inner races for scores or damaged surface areas where the rollers or sprags contact the races.
2. Inspect the rollers, sprags and springs for excessive wear or damage.
3. Inspect the spring and cage for bent or damaged spring retainers.

Case

Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions and leakage.

Inspect the case bushing for scores. Check all parking linkage parts for wear or damage.

If the transmission case thread is damaged, service kits (helicoil) may be purchased from local jobbers. To service a damaged thread, the following procedures should be carefully followed.

1. Drill out the damaged threads, **using the same drill size as the thread OD.** For example, use a 6mm drill for a M6x1 thread.
2. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being serviced. Thus, the special tap marked M6x1 will not cut the same thread as a standard M6x1 tap. It does cut a thread large enough to accommodate the insert, and after the insert is installed the original thread size (M6x1) is restored.
3. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.
4. Working through the insert, bend the insert tang straight up and down until it breaks off at the notch.
5. Improperly installed inserts can be removed with extractor tool. Place the extractor tool in the insert so that the blade rests against the top coil one-quarter to one-half turn away from the end of the coil. Tap the tool sharply with a hammer so that the blade cuts into the insert. Exert downward pressure on the tool and turn it counterclockwise until the insert is removed.

Planetary Carriers

Individual parts of the planet carriers are not serviceable.

1. The pins and shafts in the planet assemblies should be checked for loose fit and/or complete disengagement. Use a **new** planet assembly if either condition exists.
2. Inspect the pinion gears for damaged or excessively worn teeth.
3. Check for free rotation of the pinion gears.

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CLEANING AND INSPECTION (Continued)

Thrust Bearings

Wash the thrust bearings thoroughly in cleaning solvent. Blow the bearings dry with compressed air.

Make certain the bearings are clean and then lubricate with transmission fluid. Replace any bearings and races which show signs of pitting or roughness.

Converter and Oil Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and **MUST** be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter and oil cooler **MUST** be cleaned by using a mechanically agitated cleaner, such as Rotunda Torque Converter and Oil Cooler Cleaner model 014-00028 or equivalent.

Flush the converter of the remaining solvent using this procedure.

1. **Thoroughly drain** remaining solvent through the drain plug.
2. Add 1.9L (2.0 U.S. quarts) of clean transmission fluid to the converter. Agitate by hand.
3. **Thoroughly drain** solution through the drain plug.

Transmission Fluid Drain and Refill

Normal maintenance and lubrication requirements do not necessitate periodic automatic transmission fluid changes. If a major service, such as a clutch, band, bearing, etc., is required in the transmission, it will have to be removed for service. **At this time the converter transmission cooler and cooler lines must be thoroughly flushed to remove any dirt.**

When used under continuous or severe conditions, the transmission and torque converter should be drained and refilled with fluid as specified.

CAUTION: Use of a fluid other than specified could result in transmission malfunction and/or failure.

Refer to Vehicle Certification Label affixed to LH front door lock face panel or door pillar for transmission code.

When filling a dry transmission and converter, refer to Specifications for capacity. Check the fluid level.

Procedures for partial drain and refill, due to in-vehicle service operation, are as follows:

1. Raise vehicle on a hoist or jackstands. Refer to the Pre-Delivery manual, Section 50-04.
2. Place a drain pan under transmission.
3. Loosen oil pan attaching bolts and drain fluid from transmission.
4. When fluid has drained to level of pan flange, remove rest of pan bolts working from the RH side and allow it to drop and drain slowly.
5. When all fluid has drained from transmission, remove and thoroughly clean the pan. Discard gasket.
6. Place a new gasket on pan, and install pan on transmission.
7. Fill transmission to proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, part no. E4AZ-19582-B, specification ESP-M2C166-H or equivalent.
8. Lower vehicle.

Oil Cooler Tube Leakage

When fluid leakage is found at the oil cooler, the cooler must be replaced. Refer to Section 27-04.

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the old tube as a guide, bend the new tube as required. Add the necessary fittings, and install the tube.

After the fittings have been tightened, add fluid as necessary and check for fluid leaks.

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SPECIFICATIONS

Description	Torque	
	N•m	ft-lbs
Inner O.W.C. Race to Case	24-34	(18-25)
Connector to Case (Fluid) Cooler Line	24-31	(18-23)
Plug Line Pressure Case	8-16	(6-12)
Plug — Throttle Pressure Case	8-16	(6-12)
Inner and Outer Lever to Manual Control Shaft	40-54	(30-40)
Positive Detent Spring to Case	9-11	(80-100 lb. in.)
Parking Rod Guide Plate to Case	22-27	(16-20)
Neutral Switch Assembly to Case	6-8	(55-75 lb. in.)
Center Support to Hub	9-14	(80-120 lb. in.)
Center Support Fluid Feed	11-16	(8-12)
Extension Housing to Case	27-39	(20-29)
Extension Housing to Case (4x2)	27-39	(20-29)
Extension Housing to Case (4x4)	27-39	(20-29)
Stator Support to Pump Body	9-11	(80-100 lb. in.)
Oil Pump Body to Case	24-31	(18-23)
Reinforcing Plate to Case	9-11	(80-100 lb. in.)
Main Accum. and Sol. Body to Case	9-11	(80-100 lb. in.)
Main and Lower Body to Case	9-11	(80-100 lb. in.)
Lower Body to Main Body	9-11	(80-100 lb. in.)
Sol. Body to Case	9-11	(80-100 lb. in.)
Park Rod Abutment to Case	22-27	(16-20)
Control Assembly to Pump	24-31	(18-23)
Oil Pan to Case	14-16	(10-12)
Converter Drain Plug	24-27	(18-20)
O/Drive Cylinder Fluid Feed	8-14	(6-10)
Stud — Valve Body to Case Short	9-11	(80-100 lb. in.)
Stud — Valve Body to Case Long	9-11	(80-100 lb. in.)
Nut — Valve Body to Case	9-11	(80-100 lb. in.)
Nut — Manual Detent Lever	41-54	(30-40)

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Installation of Cooling Lines

Transmission	Radiator		Transmission		Fluid Line Nut	
	ft-lbs	N•m	ft-lbs	N•m	ft-lbs	N•m
E4OD	8-12	11-16	18-23	24-31	12-18	17-24

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Fluid Capacity

Type		
Motorcraft Mercon® Multi-Purpose Automatic Transmission Fluid Ford Part No. E4AZ-19582-B Ford Specification ESP-M2C166-H or equivalent		
Transmission Type	**Liters**	**Quarts**
4 x 2	16.4	15.5
4 x 4	16.9	16

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SPECIAL SERVICE TOOLS

Tool Number	Description	Tool Number	Description
T50T-100-A	Impact Slide Hammer (use w/T89T-70010-A)	T80L-7902-A	End Play Checking Tool
T59L-100-B	Impact Slide Hammer (use w/T89T-70010-A)	T81P-7902-C	Torque Converter Handles
T58L-101-B	Puller	T71P-19703-C	O-Ring Tool
T77F-1102-A	Puller	T89T-70010-A	Pump Puller Adaptors
T00L-1175-AC	Seal Remover	T89T-70010-B	Aligning Pin
T77F-1176-A	Clutch Spring Compressor	T89T-70010-C	Clutch Spring Fixture
D79P-2100-T30	Torx Bit (T-30)	T89T-70010-E	Clutch Remover/Installer
D79P-2100-T40	Torx Bit (T-40)	T89T-70010-F	Clutch Spring Compressor Plate
T78P-3504-N	Roll Pin Remover	T89T-70010-G	Stub Tube Installer
T80T-4000-W	Handle (use w/PS88B800-10)	T89T-70010-J	Gear Position Sensor Adjuster
D78P-4201-B	Dial Indicator with Magnetic Base	T88C-77000-AH2	Clutch Spring Compressor Bar
T00L-4201-C	Dial Indicator with Bracketry	T74P-77248-A	Seal Remover
T67P-7341-A	Shift Linkage Insulation Tool	T80L-77405-A	Clutch Spring Compressor
T84P-7341-A/B	Shift Linkage Grommet Remover/Replacer	T74P-77498-A	Shift Lever Seal Replacer
T61L-7657-B	Extension Housing Seal Replacer	T65L-77515-A	Clutch Spring Compressor
T77L-7697-C	Extension Housing Bushing Replacer	T77L-77548-A	Lip Seal Protector
T77L-7697-D	Extension Housing Busing Remover	T63L-77837-A	Pump Seal Replacer
D89L-77000-A	Banding Tool	T89T-70100-A	E4OD Test Harness
T57L-77820-A	Pressure Gauge	Not Available at Time of Printing	Manual Lever Position Sensor Tester

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ROTUNDA EQUIPMENT

Model	Description	Model	Description
014-00028	Torque Converter and Oil Cooler Cleaner	021-00054	Torque Converter Leak Test Kit
014-00104	C-3 Transmission Adapter Kit	014-00763	Transmission Stand Fixture
014-00106	Rotunda Twin Post Engine Stand		

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SECTION 17-10 C6 Automatic Transmission

SUBJECT	PAGE
ADJUSTMENTS	
Align Neutral Start Switch	17-10-2
Intermediate Band Adjustment	17-10-2
Vacuum Regulator Valve (VRV) Operational Check and Adjustment (Vehicles Equipped with 7.3L Diesel Engine Only)	17-10-4
DESCRIPTION	
C6 Transmission	17-10-1
Vacuum Regulator Valve (VRV)	17-10-1
DIAGNOSIS AND TESTING	17-10-2
DISASSEMBLY AND ASSEMBLY	
Control Valve Body	17-10-14
Downshift and Manual Linkage	17-10-17
Forward Clutch	17-10-21
Front Pump	17-10-19
Governor	17-10-17
Input Shell and Sun Gear	17-10-24
Intermediate Servo	17-10-17
Low-Reverse Clutch Piston	17-10-25
DISASSEMBLY AND ASSEMBLY (Cont'd)	
One-Way Clutch	17-10-24
Output Shaft Hub and Ring Gear	17-10-24
Parking Pawl Linkage	17-10-19
Reverse-High Clutch	17-10-20
Servo Apply Lever	17-10-19
Transmission	17-10-11
REMOVAL AND INSTALLATION	
Control Valve Body	17-10-8
Extension Housing	17-10-10
Extension Housing Bushing and Rear Seal	17-10-9
Governor	17-10-11
Intermediate Servo	17-10-8
Transmission	17-10-5
E-150—E-350	17-10-7
F-150—F-350 (4x2) (4x4) and Bronco	17-10-5
SPECIAL SERVICE TOOLS	17-10-30
SPECIFICATIONS	17-10-28
VEHICLE APPLICATION	17-10-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 (4x2) (4x4) and Bronco Vehicles with C-6 Automatic Transmission.

DESCRIPTION

C6 Transmission

The C6 transmission is a three speed unit capable of providing automatic upshifts and downshifts through the three forward gear ratios. The transmission is also capable of providing manual selection of first and second gears.

Fig. 1 shows the location of the converter, front pump, clutches, gear train and most of the internal parts used in the C6 transmission. The identification tag (Fig. 2), is attached to the intermediate servo lower front cover bolt. The first line on the tag shows the transmission model prefix and suffix. A number appearing after the suffix indicates that the internal parts in the transmission have been changed after initial production start-up. For example, a PGD-BN model transmission that has been changed internally would read PGD-BN1. Both transmissions are basically the same, but some service parts in the PGN-BN transmission are slightly different than the PGD-BN1 transmission. **Therefore, it is important that the codes on the transmission identification tag be checked when ordering parts or making inquiries about the transmission.**

The hydraulic control system schematic is shown in Fig. 3. The converter housing and the fixed splines which engage the splined outside diameter of the low-reverse clutch steel plates, are both cast integrally into the case.

Only one (intermediate) band is used in the C6 transmission. This along with the forward clutch is used to obtain intermediate gear.

Vacuum Regulator Valve (VRV)

Refer to Fig. 4

The Vacuum Regulator Valve (VRV) is used on E-250—E-350 and F-250—F-350 vehicles equipped with 7.3L diesel engines.

On 7.3L diesel engine trucks equipped with a C-6 automatic transmission a Vacuum Regulator Valve (VRV) is incorporated to provide a vacuum signal which is proportional to the throttle position to the vacuum diaphragm of the transmission. The VRV is necessary to provide a vacuum signal to the C-6 transmission because the diesel engine has no vacuum. The VRV is bolted to the fuel injection pump and is actuated by the throttle lever.

A constant vacuum source is supplied to the VRV by an engine driven vacuum pump which also delivers vacuum to other accessories. The VRV regulates an output vacuum signal to the transmission's vacuum diaphragm which is proportional to the throttle position. As the throttle is opened, the regulated vacuum from the VRV drops.

Should a malfunction occur in the VRV, the valve will cause a 0 vacuum signal to be sent to the diaphragm which will cause delayed and harsh shifts to occur.

Anytime delayed or harsh up-shifts are encountered, the performance of the VRV should be checked prior to performing any transmission repairs. Should the VRV be replaced or the fuel injection pump be removed, the VRV must be adjusted to specifications.

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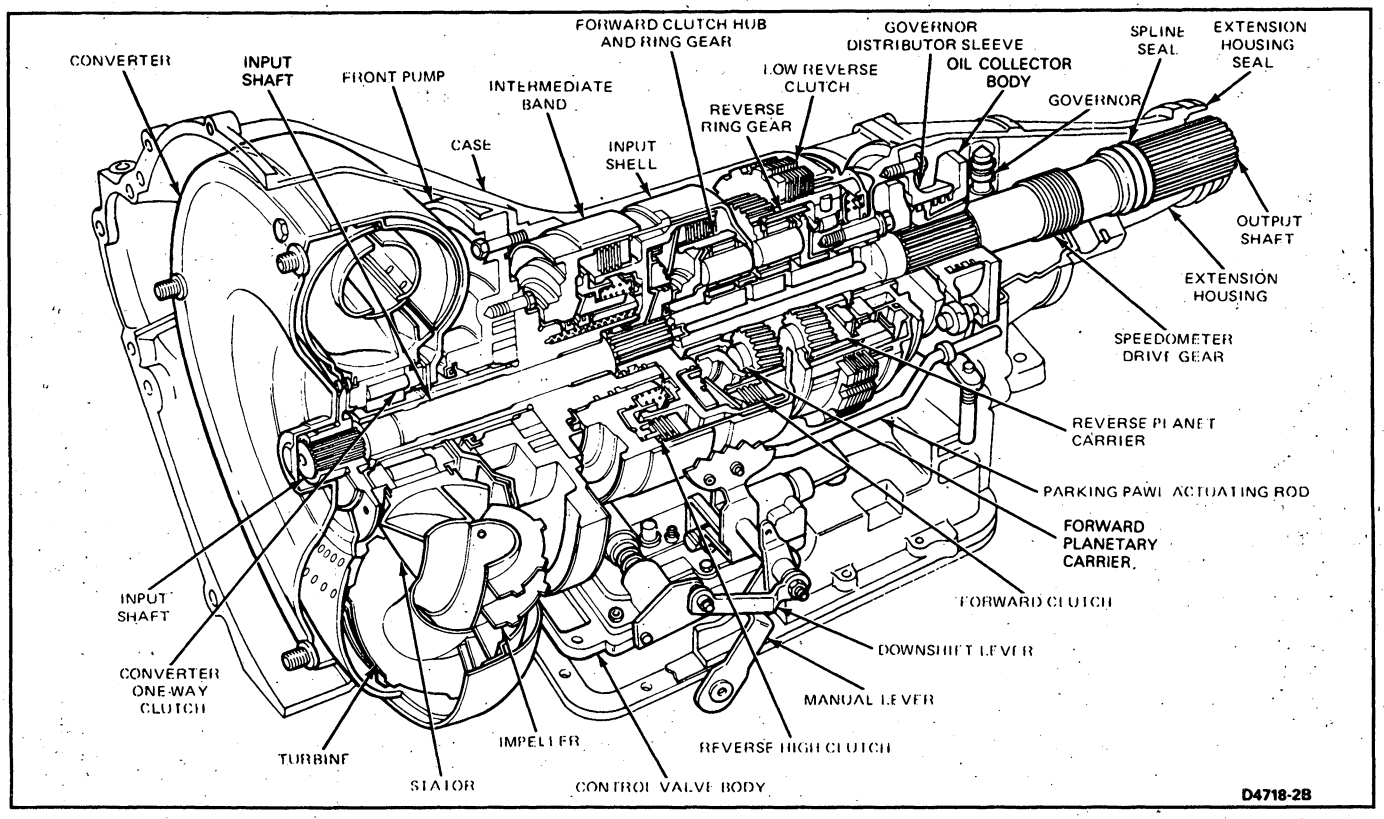


FIG. 1 C6 Automatic Transmission—Sectional

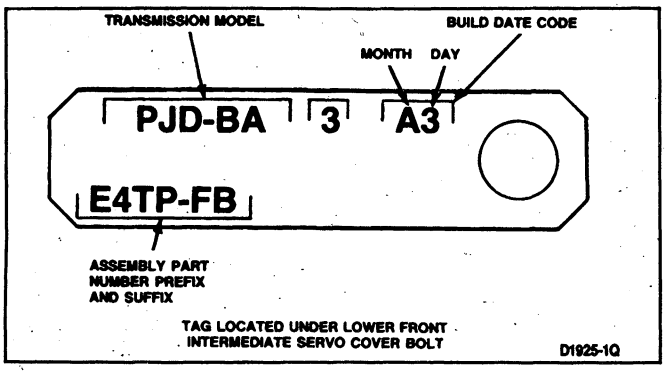


FIG. 2 Identification Tag

DIAGNOSIS AND TESTING

Refer to Section 17-01, General Automatic Transmission Service.

ADJUSTMENTS

The only adjustments on the transmission are the intermediate band and the NEUTRAL START switch (and the Vacuum Regulator Valve on vehicles equipped with 7.3L diesel engines).

On vehicles equipped with 7.3L Diesel Engines, the Vacuum Regulator Valve (VRV), which is located on the fuel injector pump must be properly adjusted to regulate vacuum to the transmission vacuum diaphragm.

To prevent damage to the transmission and to assure proper band adjustment, it is essential that the tools and procedures described here are used whenever the band is adjusted.

Intermediate Band Adjustment

1. Raise the vehicle on a hoist or jack stands.
2. Clean all the dirt from the band adjusting screw. Remove and discard locknut.
3. Install a new locknut and tighten the adjusting screw to 14 N·m (10 ft-lbs) torque (Fig. 5).
4. **Back off the adjusting screw exactly 1-1/2 turns.**
5. Hold the adjusting screw from turning and tighten the locknut to 48-61 N·m (35-40 ft-lbs).
6. Lower the vehicle.

Align Neutral Start Switch

1. Apply the parking brake.
2. With the manual linkage properly adjusted, loosen the two switch attaching bolts (Fig. 6).
3. Place the transmission manual lever in NEUTRAL. Rotate the switch and insert the gauge pin (No. 43 drill shank end) into the gauge pin holes of the switch. The gauge pin has to be inserted a full 12.303mm 31/64 inch into the three holes of the switch (Fig. 6).
4. Tighten the two neutral start switch attaching bolts to 6.5-8.0 N·m (55-75 in-lbs). Remove the gauge pin from the switch.
5. Check the operation of the switch. The back up lamps should operate only with the transmission selector lever in **REVERSE.** The vehicle should start only with the transmission selector lever in **PARK** and **NEUTRAL.**

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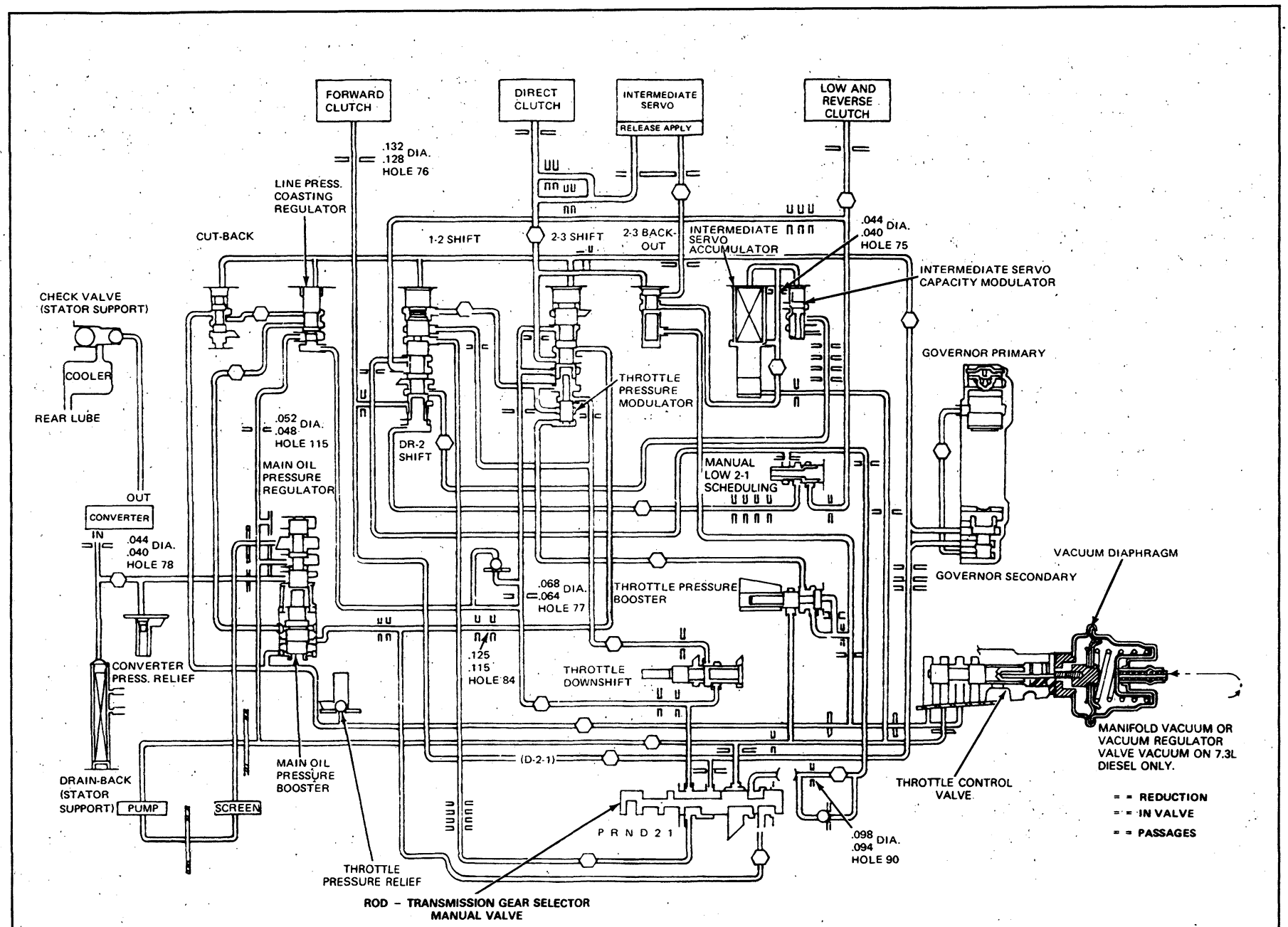


FIG. 3 Hydraulic Control System—C6 Transmission

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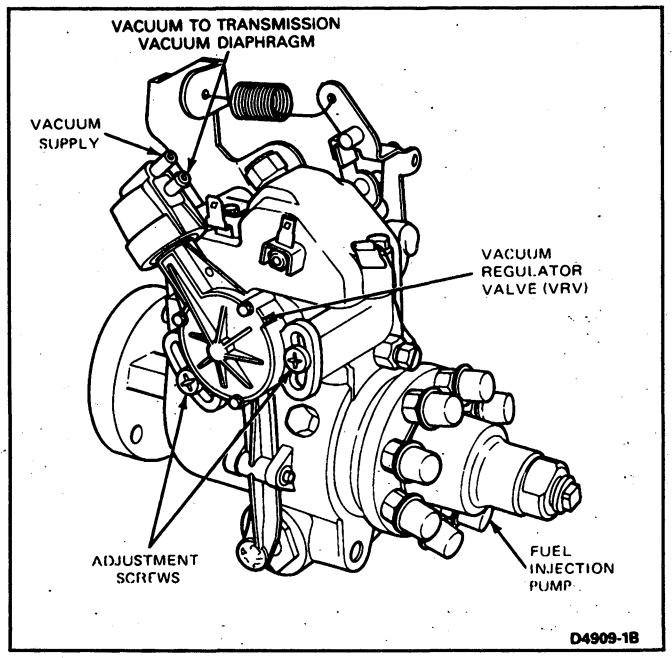


FIG. 4 Vacuum Regulator Valve (VRV)—E-250—E-350, F-250—F-350 with 7.3L Diesel Engine

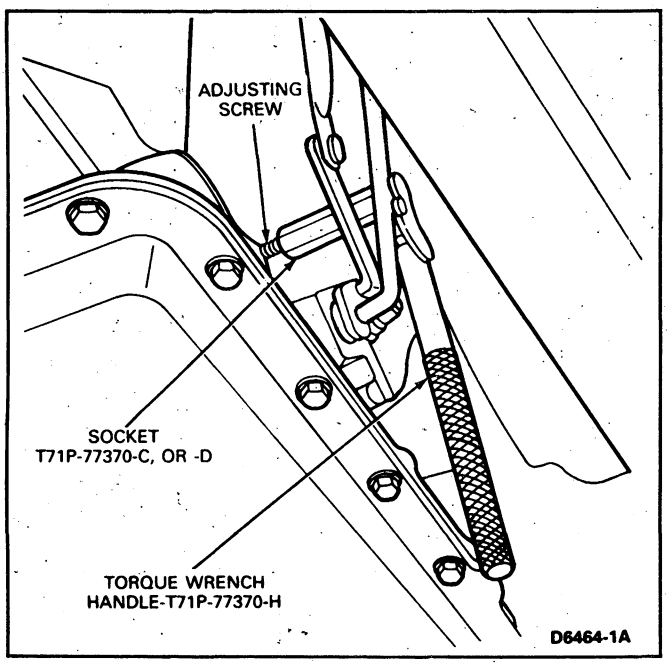


FIG. 5 Adjusting Intermediate Band

Vacuum Regulator Valve (VRV) Operational Check and Adjustment (Vehicles Equipped with 7.3L Diesel Engine only)

Refer to Fig. 4

To check the VRV for proper operation and to adjust, the engine must not be running (TURNED OFF).

1. Disconnect the two port vacuum connector from the VRV located on the left side of the fuel injection pump.
2. Remove the throttle cable from the throttle lever on the right side of the fuel injection pump.

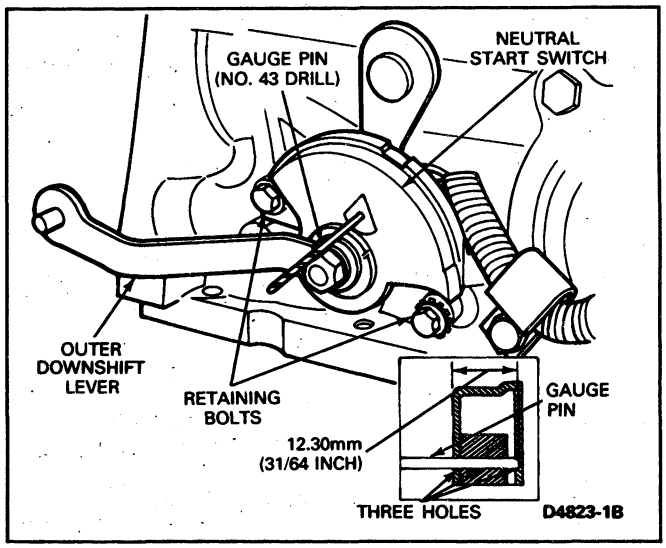


FIG. 6 Neutral Start and Back Up Lamp Switch

3. Remove the throttle return spring. Install the end of the spring over the throttle lever ball stud and the other end over the throttle cable support bracket.
4. Attach a vacuum pump to the upper port of the VRV (vacuum supply side).
5. Attach a vacuum gauge to the lower port of the VRV, labeled TRANS on the VRV.
6. Apply 20 inches minimum of vacuum to the VRV and maintain. **It will be necessary to continually pump the vacuum up as it bleeds off (this is normal). Cycle the throttle lever 5 times from idle to WOT** with vacuum applied. Insert the gauge block, T83T-7B200-AH (0.515 inch), between the pump boss and the throttle wide-open stop (Fig. 7). The throttle return spring (F-Series), as repositioned in step 3 below, will hold the throttle lever stop against the gauge block (Hold throttle lever open on Econoline by other means). **The vacuum gauge attached to the lower port of the VRV should indicate 6-8 inches of vacuum. If the vacuum reading is not correct, adjust the VRV to achieve a reading of 7 inches (± .5) of vacuum.**
7. To adjust, loosen the two adjustment screws that attach the VRV to the fuel injection pump (Fig. 4). Rotate the VRV until the proper vacuum is obtained. Tighten the two adjusting screws to 8-10.5 N·m (75-90 in-lbs) when the proper vacuum reading is obtained. If the VRV can not be adjusted to obtain the proper vacuum, replace the VRV and repeat procedure from Step 3.
8. Remove the gauge block.
9. Reattach the throttle return spring and throttle cable.
10. Again apply 20 inches of vacuum to the VRV and **while maintaining vacuum, cycle the throttle lever from idle to WOT 5 times.** The vacuum gauge must indicate at least 13 inches (throttle at idle position). If the vacuum gauge indicates less than 13 inches the VRV must be replaced and the new VRV adjusted per the above procedures.
11. After making the check or adjustment, remove the vacuum pump and gauge from the VRV and reattach the vacuum connector.

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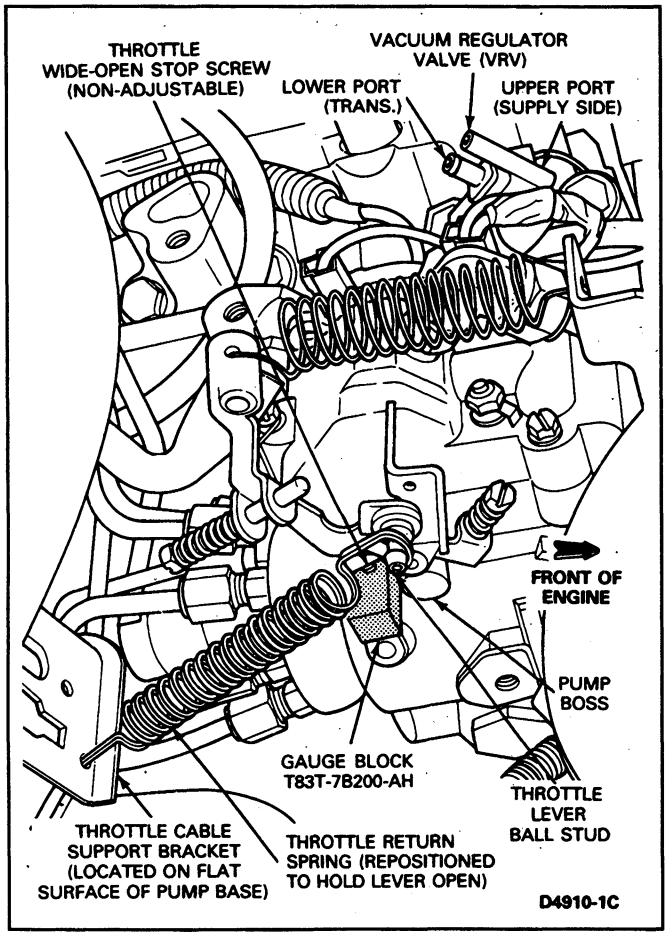


FIG. 7 VRV Gauge Block Installation

12. Start engine and check throttle operation and check transmission shifts.

REMOVAL AND INSTALLATION

Transmission

F-150—F-350 (4x2) (4x4) and Bronco

Removal

1. Drive the vehicle on a hoist, but do not raise at this time. Disconnect the battery negative cable. Disconnect neutral switch wire at the plug connector.
2. Raise the vehicle on a hoist or stands.
3. Place the drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold it in place.
4. Remove the converter drain plug access cover from the lower end of the converter housing.
5. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the bump switch.
6. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Place a drain pan under the converter to catch the fluid and remove the plug. After the fluid has been drained, re-install the plug.
7. On (4x2) applications disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission. Install a seal installation tool in the extension housing to prevent fluid leakage.
8. Disconnect the speedometer cable from the extension housing.
9. Disconnect the downshift and manual linkage rods or cable controls from the levers at the transmission.
10. Disconnect the oil cooler lines from the transmission.
11. Remove the vacuum hose from the vacuum diaphragm unit. Remove the vacuum line from the retaining clip.
12. Disconnect the cable from the terminal on the starter motor. Remove the three attaching bolts and remove the starter motor.
13. On F-150—F-350 (4x4) and Bronco vehicles, remove the transfer case. Refer to Section 16-80, Borg Warner 13-56 Electronic Shift Transfer Case, 16-81, Borg Warner 13-56 Transfer Case—Manual Shift, or Section 16-86, Borg Warner 1345 Transfer Case.
14. Remove the two engine rear support and insulator assembly-to-attaching bolts (Fig. 8).
15. Remove the two engine rear support and insulator assembly-to-extension housing attaching bolts (Fig. 8).
16. Remove the six bolts securing the No. 2 crossmember to the frame side rails (Fig. 8).
17. Raise the transmission with a transmission jack and remove the crossmember.
18. Secure the transmission to the jack with the safety chain.
19. Remove the converter housing-to-engine attaching bolts.
20. Move the transmission away from the engine. Lower the jack and remove the converter and transmission assembly from under the vehicle.

Installation

1. Tighten the converter drain plug to 11-37 N·m (18-28 ft-lbs).
2. Position the converter on the transmission making sure the converter drive flats are fully engaged in the pump gear.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with the chain.
4. Rotate the converter until the studs and drain plug are in alignment with their holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot. **The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft. Do not allow converter drive flats to disengage from pump gear.**

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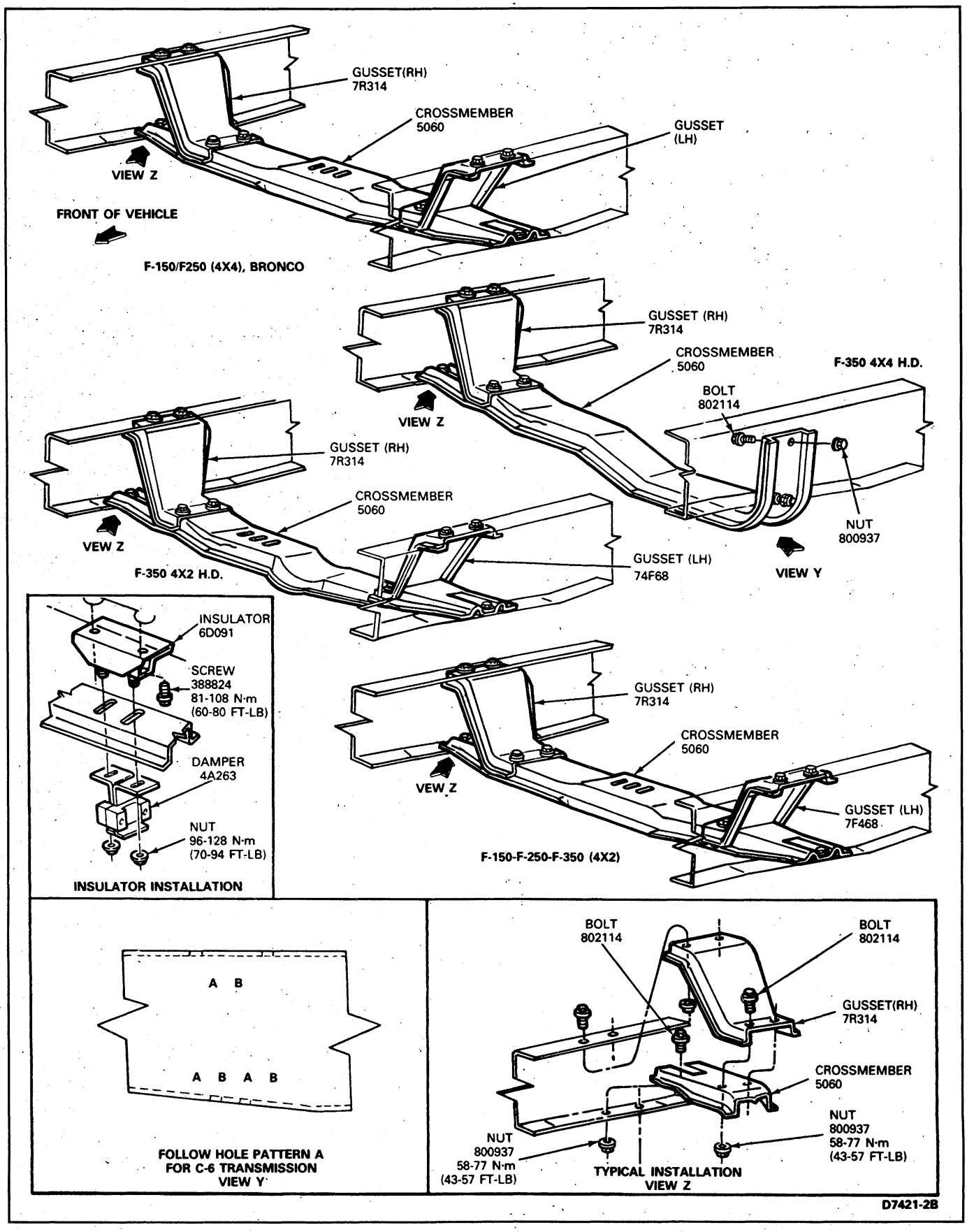


FIG. 8 Crossmember Installation F-150—F-350 (4x2) (4x4)

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6. Install and tighten the converter housing-to-engine attaching bolts to 55-67 N·m (40-50 ft-lbs) on gasoline engines and 67-87 N·m (50-65 ft-lbs) on diesel engines.
7. Remove the transmission jack safety chain from around the transmission.
8. Position the No. 2 crossmember to the frame side rails. Install and tighten the attaching bolts to specifications as listed at the end of this Section.
9. Install transfer case on F-150—F-250 (4x4) and Bronco. Refer to Section 16-80, Borg Warner 13-56 Electronic Shift Transfer Case, 16-81, Borg Warner 13-56 Transfer Case—Manual Shift, or Section 16-86, Borg Warner 1345 Transfer Case.
10. Position the engine rear support and insulator assembly above the crossmember. Install the rear support and insulator assembly-to-extension housing mounting bolts and tighten the bolts to specifications as listed at the end of this Section.
11. Lower the transmission and remove the jack.
12. Secure the engine rear support and insulator assembly to the crossmember with the attaching bolts and tighten them to specifications as listed at the end of this Section.
13. Connect the vacuum line to the vacuum diaphragm making sure that the line is in the retaining clip.
14. Connect the oil cooler lines to the transmission.
15. Connect the downshift and manual linkage rods or cable controls to their respective levers on the transmission. Refer to Section 17-02 Shift Control Linkage, Removal and Installation.
16. Connect the speedometer cable to the extension housing.
17. Secure the starter motor in place with the attaching bolts. Connect the cable to the terminal on the starter.
18. Install a new O-ring on the lower end of the transmission filler tube and insert the tube in the case.
19. Secure the converter-to-flywheel attaching nuts and tighten them to 28-40 N·m (20-30 ft-lbs).
20. Install the converter housing access cover and secure it with the attaching bolts.
21. Connect the driveshaft.
22. Fill the transmission to the proper level with the specified fluid.
23. Adjust the shift linkage as required. Refer to Section 17-02, Shift Control Linkage.
24. Connect neutral switch wire to plug connector.
25. Connect the battery negative cable.

Transmission

E-150—E-350

Removal

1. Disconnect the battery negative cable.
2. Working from inside the vehicle, remove the engine compartment cover.
3. Disconnect the neutral start switch wires at the plug connector.
4. If the vehicle is equipped with a V-8 engine, remove the flexhose from the air cleaner heat tube.
5. Remove the bolt securing the filler tube to the engine.
6. Raise the vehicle on a hoist.
7. Place the drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold it in place.
8. Remove the converter drain plug access cover from the lower end of the converter housing.
9. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the nuts.
10. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Place a drain pan under the converter to catch the fluid. Then, remove the plug. With fluid drained, re-install the plug.
11. Disconnect the driveshaft.
12. Remove fluid filler tube.
13. Disconnect the starter cable at the starter. Remove the starter-to-converter housing attaching bolts and remove the starter.
14. Position an appropriate engine support bar to the frame and engine oil pan flanges.
15. Disconnect the cooler lines from the transmission. Disconnect the vacuum line from the vacuum diaphragm unit. Remove the vacuum line from the retaining clip at the transmission.
16. Remove the speedometer driven gear from the extension housing.
17. Disconnect the manual and downshift linkage rods or cable controls from the transmission control levers.
18. Position a transmission jack to support the transmission. Install the safety chain to hold the transmission.
19. Remove the bolts and nuts securing the rear support and insulator assembly to the crossmember. Remove the six bolts retaining the crossmember to the side rails and remove the two support gussets. Raise the transmission with the jack and remove the crossmember (Fig. 9).
20. Remove the converter housing-to-engine attaching bolts. Lower the jack and remove the converter and transmission assembly from under the vehicle.
21. Remove the converter and mount the transmission in a holding fixture.

Installation

1. Tighten the converter drain plug to specification as listed at the end of this Section.
2. Position the converter on the transmission making sure the converter drive flats are fully engaged in the pump gear.

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3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with the safety chain.
4. Rotate the converter until the studs and drain plug are in alignment with their holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot.

   The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft. Do not allow converter drive flats to disengage from pump gear.
6. Install the converter housing-to-engine attaching bolts. Tighten the bolts to 55-67 N·m (40-50 ft-lbs) on gasoline engines and 67-87 N·m (50-65 ft-lbs) on diesel engines. Install the converter-to-flywheel attaching nuts. Tighten the nuts to 28-40 N·m (20-30 ft-lbs).
7. Install the crossmember. Install the rear support and insulator assembly-to-crossmember attaching bolts and nuts. Tighten the bolts to specifications as listed at the end of this Section.
8. Remove the safety chain and remove the jack from under the vehicle. Remove the engine support bar.
9. Install a new O-ring on the lower end of the transmission filler tube and insert the tube and dipstick in the case.
10. Connect the vacuum line to the vacuum diaphragm making sure the line is secured in the retaining clip.
11. Connect the cooler lines to the transmission.
12. Install the speedometer driven gear into the extension housing. Tighten the attaching bolt to specifications as listed at the end of this Section.
13. Connect the transmission linkage rods to the transmission control levers. When making transmission control attachments new retaining ring and grommet should always be used (see Removal and Installation in Section 17-02, Shift Control Linkage). Note precautions necessary to prevent grommet damage. Attach the shift rod to the steering column shift lever (refer to Fig. 2, Section 17-02, Shift Control Linkage). Align the flats of the adjusting stud with the flats of the rod slot and insert the stud through the rod. Assemble the adjusting stud nut and washer to a loose fit. Perform a linkage adjustment as outlined in Section 17-02, Shift Control Linkage.
14. Install the converter housing access cover and tighten the attaching bolts to 17-21 N·m (12-16 ft-lbs).
15. Position the starter into the converter housing and install the attaching bolts. Tighten the bolts to 55-67 N·m (40-50 ft-lbs) on gasoline engines and 67-87 N·m (50-65 ft-lbs) on diesel engines. Install the starter cable.
16. Install the driveshaft.
17. Lower the vehicle.
18. On V-8 engines, install the flex hose to the air cleaner heat tube. Install the bolt that retains the filler tube to the cylinder block.
19. Connect the neutral start switch wires at the plug connector.
20. Fill the transmission to the proper level with the specified fluid.
21. Raise the vehicle and check for transmission fluid leakage. Make sure the transmission fluid pan is securely attached. Lower the vehicle and adjust the downshift and manual linkage. Refer to Section 17-02, Shift Control Linkage.
22. Connect the battery negative cable.
23. Install the engine compartment cover.

Control Valve Body

Refer to Fig. 17.

Removal

1. Raise the vehicle on a hoist or jack stands.
2. Place a drain pan under the transmission and loosen the bolts holding the transmission pan to drain the fluid from the transmission.
3. Remove the transmission pan attaching bolts from both sides and the rear to allow the fluid to drain further. Finally, remove the remainder of the attaching bolts. Remove the pan and gasket. Remove and discard the nylon shipping plug from the pan. This plug is used to retain transmission fluid within the transmission during shipment and should be discarded when the oil pan is removed.
4. Remove the valve body attaching bolts and remove the valve body from the case.

Installation

1. Position the valve body to the case making sure that the selector and downshift levers are engaged. Install and tighten the attaching bolts to 11-14 N·m (95-125 in.-lbs).
2. Clean the transmission pan and gasket surfaces thoroughly.
3. Using a new pan gasket, install attaching bolts securing the pan to the transmission case. Tighten the attaching bolts to 10.5-17 N·m (8-12 ft-lbs).
4. Lower the vehicle and fill the transmission to the correct level with the specified fluid.

Intermediate Servo

(Refer to Fig. 10).

Removal

1. Raise the vehicle on a hoist or stands.
2. Remove the bolts that secure the engine rear support to the transmission extension rear support and insulator assembly to the crossmember.
3. Remove the two crossmember-to-frame attaching bolts, and the bolts attaching the gussets to the crossmember if so equipped.
4. Raise the transmission high enough to remove the weight from the crossmember and remove the crossmember.
5. Disconnect the muffler inlet pipe from the exhaust manifolds and allow the pipe to hang.
6. Place a drain pan under the servo. Remove the bolts that attach the servo cover to the transmission case.
7. Remove the cover, piston, spring and gasket from the case, screwing the band adjusting screw inward as the piston is removed. This places

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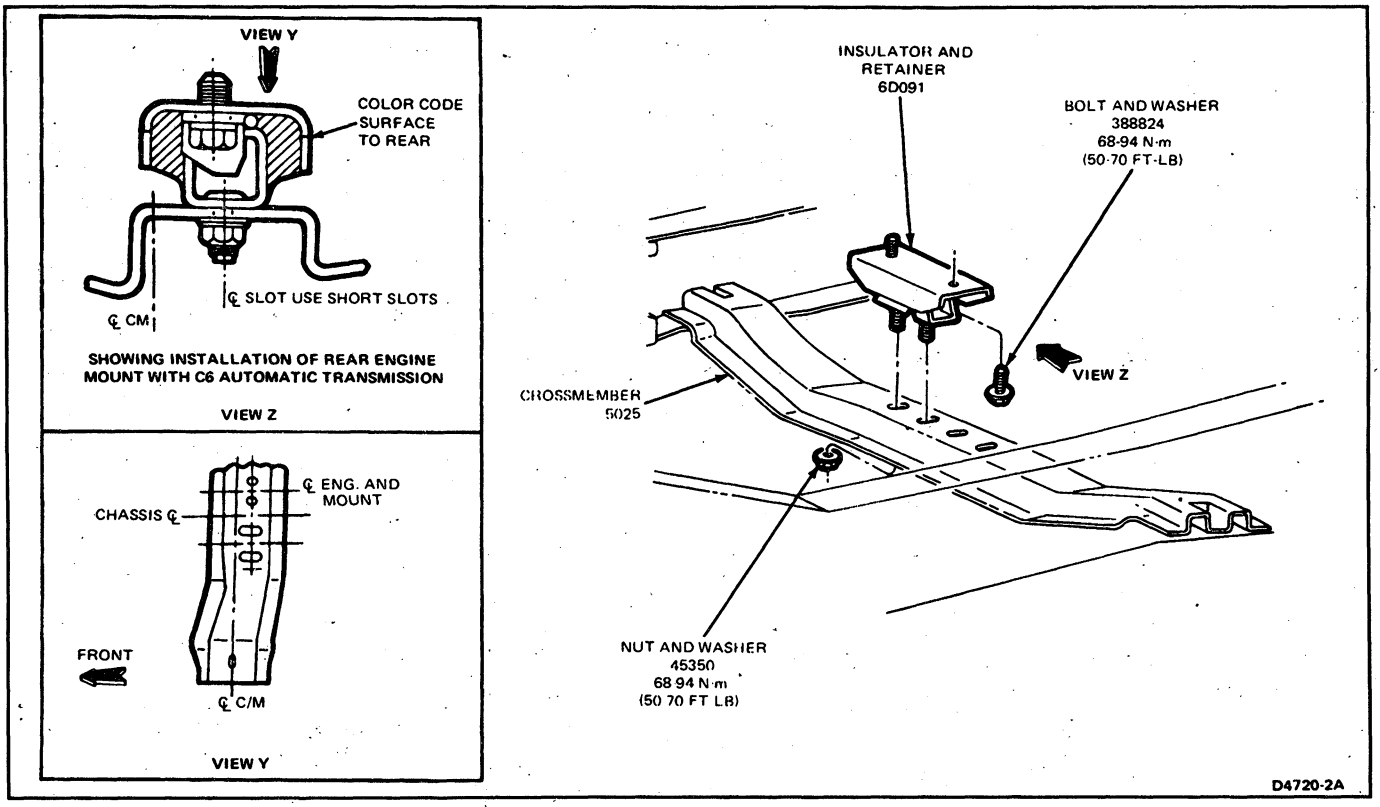


FIG. 9 Crossmember Installation—E-150—E-350

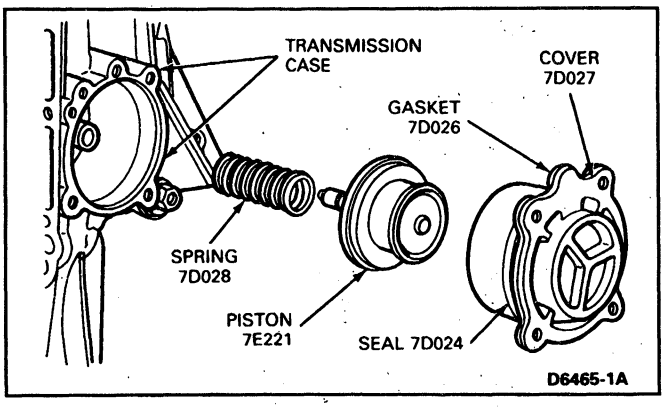


FIG. 10 Intermediate Servo Disassembled—Typical

enough tension on the band to keep the struts properly engaged in the band end notches while the piston is removed.

8. Apply air pressure to the port in the servo cover to remove the piston and rod.
9. Replace the complete piston and rod assembly if the piston or piston sealing lips are damaged, (Fig. 10).
10. Remove the seal from the cover.

Installation

1. Dip the new seal in transmission fluid.
2. Install a new seal on the cover.
3. Coat new gasket with petroleum jelly, and position on the servo cover.
4. Dip the piston in transmission fluid and install it in the cover.
5. Position the servo spring on the piston rod.
6. Insert the servo piston and cover in the case and secure the cover to the case with the attaching bolts, taking care to back off the band adjusting screw as the cover bolts are tightened 19-27 N·m (14-20 ft-lbs). **Make sure that the service identification tag is in place.**
7. Connect the muffler inlet pipe to the exhaust manifolds.
8. Raise the transmission high enough to install the crossmember. Secure the crossmember to the rear support with the attaching bolts. Lower the transmission as required to install the crossmember to frame and gussets attaching bolts. Tighten the attaching bolts to specifications as listed at the end of this Section.
9. Remove the jack from the transmission. Adjust the band as detailed in the Adjustment portion of this Section.
10. Lower the vehicle and replenish the fluid as required. Refer to Section 17-01 General Automatic Transmission Service.

Extension Housing Bushing and Rear Seal

E-150—E-350, F-150—F-350 (4x2)

Removal

1. Raise the vehicle and disconnect the driveshaft at the transmission.
2. When only the rear seal needs replacing, carefully remove it with a tapered chisel or the Tools, T50T-100-A and TOOL-1175-AC, shown in Fig. 11. Remove the bushing using Tool T77L-7697-D or equivalent as shown in Fig. 12. **Use the bushing**

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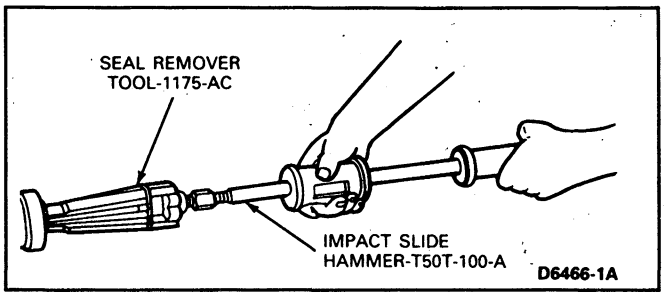


FIG. 11 Removing Extension Housing Seal

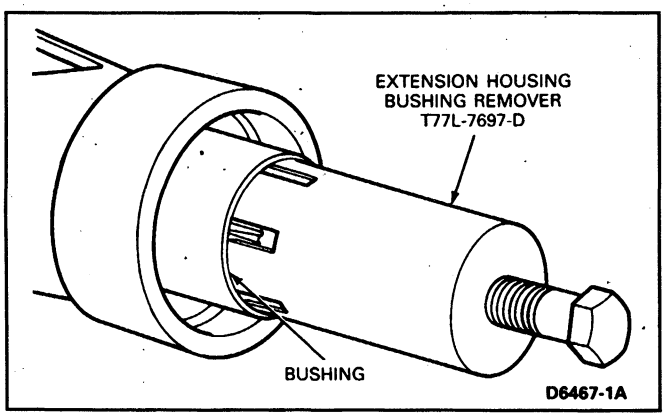


FIG. 12 Removing Extension Housing Bushing

remover carefully so that the spline seal is not damaged.

Installation

1. When installing a new bushing use the special Tool T77L-7697-C shown in Fig. 13.
2. Before installing a new seal, inspect the sealing surface of the universal joint yoke for scores. If scores are found, replace the yoke.
3. Inspect the counterbore of the housing for burrs. Remove burrs with crocus cloth.
4. Install the seal into the housing with Tool T61L-7657-B shown in Fig. 14, or an equivalent. The seal should be firmly seated in the bore. Coat the inside diameter of the end of the seal with Long-Life Lubricant, C1AZ-19590-BA (ESA-M1C75-B) or an equivalent lubricant.
5. Coat the front universal joint spline with Long-Life Lubricant C1AZ-19590-BA (ESA-M1C75-B) or an equivalent lubricant and install the driveshaft.

Extension Housing

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the driveshaft from the rear axle flange and remove it from the transmission. On 4x4 vehicles, remove the transfer case. Refer to Section 16-80, Borg Warner 13-56 Electronic Shift Transfer Case, 16-81 Borg Warner 13-56 Transfer Case-Manual Shift, or 16-86, Borg Warner 1345 Transfer Case.
3. Disconnect the speedometer cable from the extension housing.
4. Remove the engine rear support and insulator assembly-to-extension housing attaching bolts.

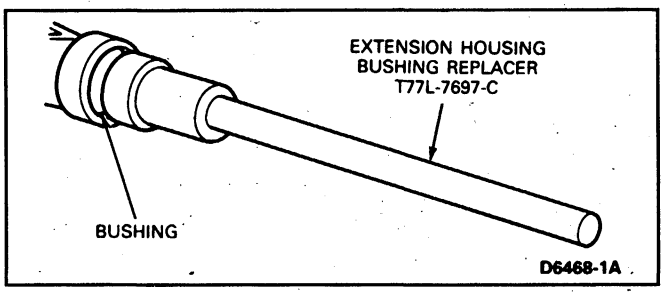


FIG. 13 Installing Extension Housing Bushing

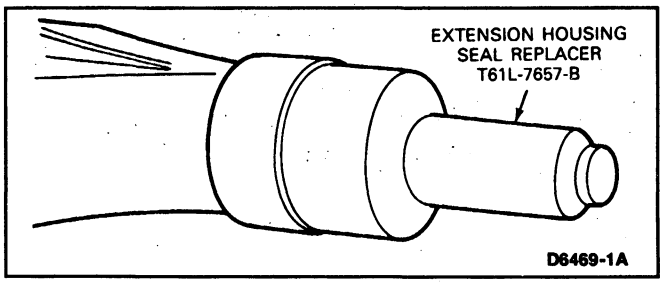


FIG. 14 Installing Extension Housing Seal

5. Place a jack under the transmission and raise it just enough to remove the weight from the engine rear support.
6. Remove the bolts that secure the engine rear support to the crossmember and remove the support.
7. Place a drain pan under the rear of the transmission case.
8. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.

Installation

1. Clean the mounting surface on the transmission case and on the extension housing. Position a new gasket on the transmission case.
2. Hold the extension housing in place and secure it with the attaching bolts. Tighten bolts to 34-47 N·m (25-35 ft-lbs).
3. Raise the transmission high enough to position the engine rear support on the crossmember.
4. Secure the support to the crossmember with the attaching bolts and nuts. Tighten the bolts to specification as listed at the end of this Section.
5. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolts. Tighten bolts to specification as listed at the end of this Section. On 4x4 vehicles, install the transfer case. Refer to Section 16-80, 16-81 or 16-86.
6. Secure the speedometer cable to the extension housing with the attaching bolt.
7. Install the driveshaft and lower the vehicle to the floor.
8. Fill the transmission to the correct level with the specified fluid.

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Governor

Removal

1. Remove the extension housing as outlined in this Section.
2. Remove the four governor body-to-oil-collector attaching bolts (Fig. 15).
3. Remove the governor from the collector body flange.
4. Refer to the Disassembly and Assembly Section of this Section for Governor repair operations.

Installation

1. Secure the governor (Fig. 15) to the oil collector flange with the attaching bolts. Tighten the bolts to 10.5-13.5 N·m (90-120 in.-lbs).
2. Re-install the extension housing as outlined in this Section.

DISASSEMBLY AND ASSEMBLY

Transmission

Refer to Fig. 38.

Before removing any of the subassemblies, thoroughly clean the outside of the transmission to prevent dirt from entering the mechanical parts.

During the repair of the subassemblies, certain general instructions which apply to all units of the transmission must be followed. Following these instructions will avoid unnecessary repetition.

Handle all transmission parts carefully to avoid nicking or burring the bearing or mating surfaces. Lubricate all internal parts of the transmission with clean automatic transmission fluid before assembly.

Do not use any other lubricants except on gaskets and thrust washers. These may be coated with petroleum jelly to facilitate assembly. Always use new gaskets and seals when assembling a transmission. Refer to Section 17-01, General Automatic Transmission Service for Cleaning and Inspection Procedures.

Tighten all bolts and screws to the recommended torque as outlined in specifications at end of this Section.

Disassembly

1. Remove the converter, and mount the transmission in holding fixture Rotunda Model 014-00106 or equivalent, (Fig. 16).

   NOTE: If equipped, remove and discard the nylon shipping plug from the pan. This plug is used to retain transmission fluid within the transmission during shipping. It should be discarded when the oil pan is removed.
2. Remove the 17 fluid pan attaching bolts. Remove the pan and gasket.
3. Remove the eight valve body attaching bolts. Lift the valve body (Fig. 17) from the transmission case.

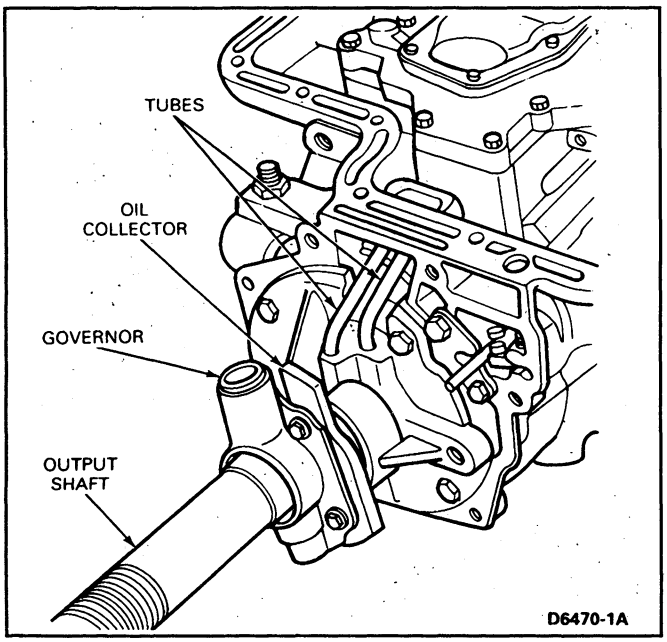


FIG. 15 Governor Installed

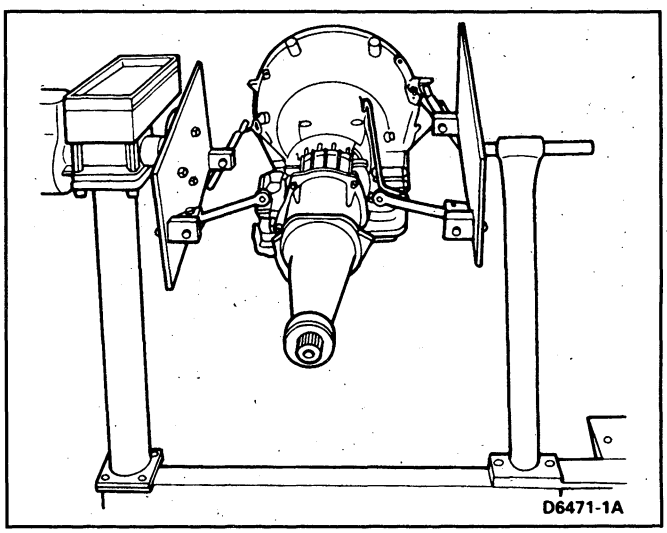


FIG. 16 Transmission Mounted in Holding Fixture

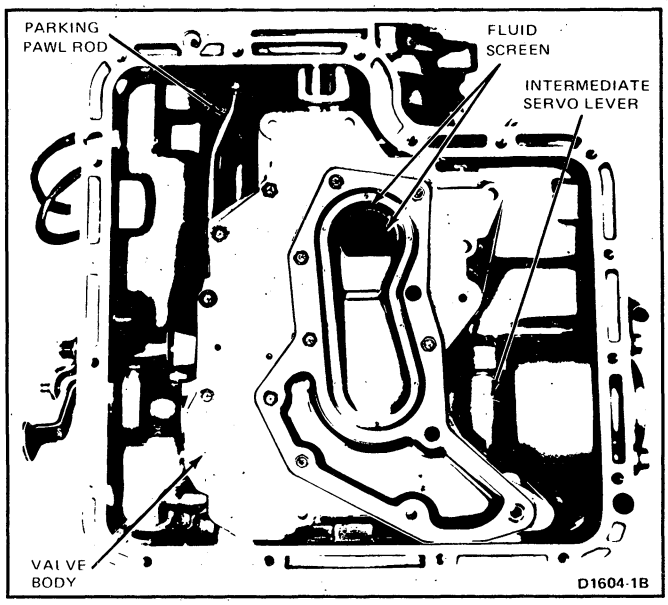


FIG. 17 Transmission With Pan Removed

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4. Attach a dial indicator TOOL-4201-C or equivalent to the front pump as shown in Fig. 18. Install Extension Housing Seal Replacer T61L-7657-B in the extension housing to center the output shaft.

5. Pry the gear train to the rear of the case and at the same time, press the input shaft inward until it bottoms, (Fig. 18). Set the dial indicator to read zero.

6. Pry the gear train forward, (Fig. 18), and note the amount of gear train end play on the dial indicator. Record the end play to facilitate assembling the transmission. Remove the dial indicator from the pump and the tool from the extension housing.

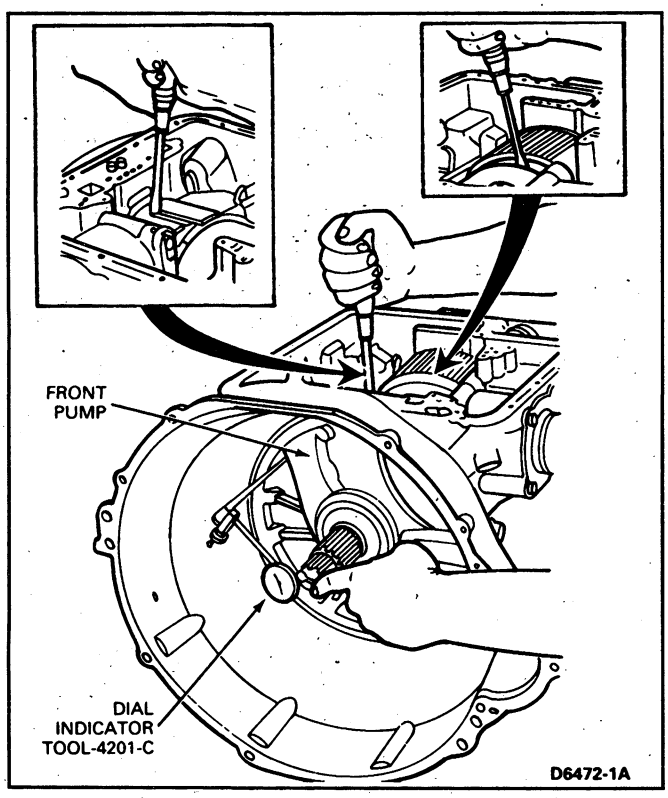


FIG. 18 Checking Gear Train End Play

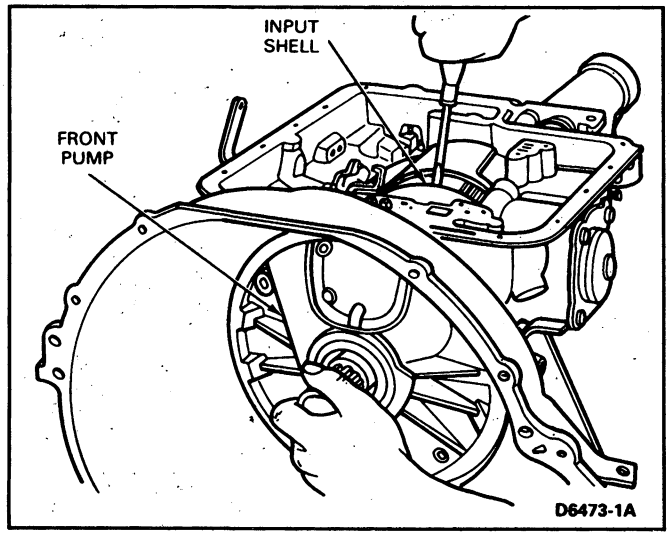


FIG. 19 Removing Front Pump

7. Remove the vacuum diaphragm, valve rod and the throttle valve from the bore in the rear of the case. Slip the input shaft out of the front pump.

8. Remove the front pump attaching bolts. Pry the gear train forward as shown in Fig. 19 to remove the pump.

9. Loosen the band adjustment screw and remove the two struts.

10. Rotate the band 90 degrees counterclockwise to align the ends with the slot in the case (Fig. 20). Slide the band off the reverse-high clutch drum.

11. Remove the forward part of the gear train as an assembly as shown in Fig. 21.

12. Remove the bolts that attach the servo cover to the transmission case.

13. Remove the cover, piston, spring and gasket from the case.

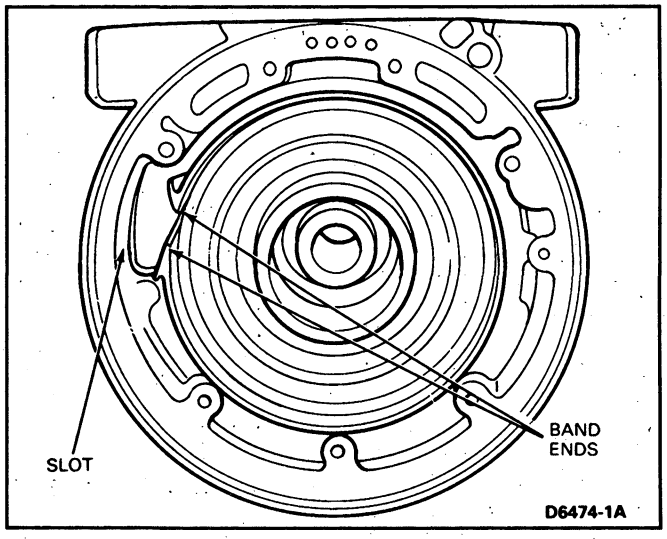


FIG. 20 Removing or Installing Band

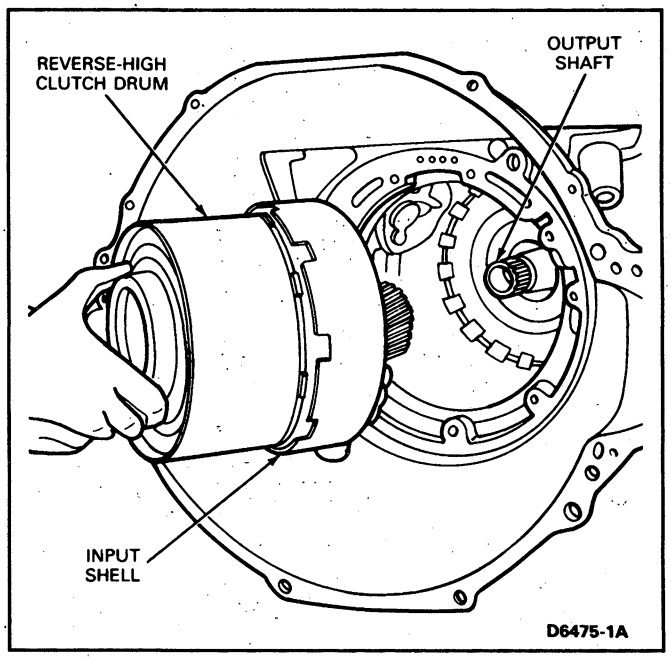


FIG. 21 Removing or Installing Forward Part of Gear Train

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14. Remove the large snap ring that secures the reverse planet carrier in the low-reverse clutch hub. Lift the thrust washers and planet carrier from the drum.
15. Remove the snap ring, (Fig. 22), that secures the reverse ring gear and hub on the output shaft. Slide the ring gear and hub off the shaft. Remove the thrust washer.
16. Rotate the low-reverse clutch hub in a clockwise direction and at the same time, withdraw it from the case.
17. Remove the reverse clutch snap ring from the case, then remove the clutch discs, plates and pressure plate from the case.
18. Remove the extension housing attaching bolts from the case. Remove the extension housing and gasket.
19. Slide the output shaft (with governor and oil collector) assembly from the transmission case.
20. Remove the distributor sleeve attaching bolts and remove the sleeve, parking pawl gear and the thrust washer.

    If the thrust washer is staked in place, use a sharp chisel and cut off the metal from behind the thrust washer. Be sure to clean the rear of the case with air pressure or a suitable solvent to remove any metal particles.
21. Remove the one-way clutch inner race attaching bolts from the rear of the case. Remove the inner race and reverse clutch spring retainer assembly from inside of the case.
22. Remove the low-reverse clutch piston from the case using TOOL-7000-DE or equivalent as shown in Fig. 23.

Assembly

1. Place the transmission case in a holding fixture.
2. Tap the low-reverse piston into place in the case with a clean rubber hammer.
3. Install the low-reverse clutch spring retainer assembly and retainer assembly in the clutch piston.
4. Hold the one-way clutch inner race in position and install the attaching bolts. Tighten bolts to 25-33 N·m (18-25 ft-lbs).
5. Place the transmission case on the bench with the front end facing downward.
6. Position the parking gear thrust washer and the gear on the case (Fig. 31). **Do not re-stake the thrust washer.**
7. Position the collector and tubes in place on the rear of the case. Install the attaching bolts and tighten to 17-21 N·m (12-16 ft-lbs).
8. Install the output shaft, and governor as an assembly.
9. Place a new gasket on the rear of the transmission case. Position the extension housing on the case and install the attaching bolts. Tighten the attaching bolts to 34-47 N·m (25-35 ft-lbs).
10. Place the transmission case in the holding fixture.
11. Coat new gasket with petroleum jelly and position on the servo cover.
12. Position the servo spring on the piston rod.
13. Insert the servo piston rod in the case. Install the servo cover with the attaching bolts, making sure that the identification tag is in place. Tighten the attaching bolts to 19-27 N·m (14-20 ft-lbs).
14. Align the low-reverse clutch hub and one-way clutch with the inner race at the rear of the case. Rotate the low-reverse clutch hub clockwise while applying pressure to seat it on the inner race.
15. Install the low-reverse clutch plates, starting with the wave plate next to the piston and following with steel and friction plates alternately. Retain them with petroleum jelly. If new composition plates are being used, soak them in clean transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2QDX or DDX (ESP-M2C166-H), or equivalent for fifteen minutes before installation. Install the pressure plate and the snap ring. Test the operation of the low-reverse clutch by applying air pressure at the clutch pressure apply hole in the case.

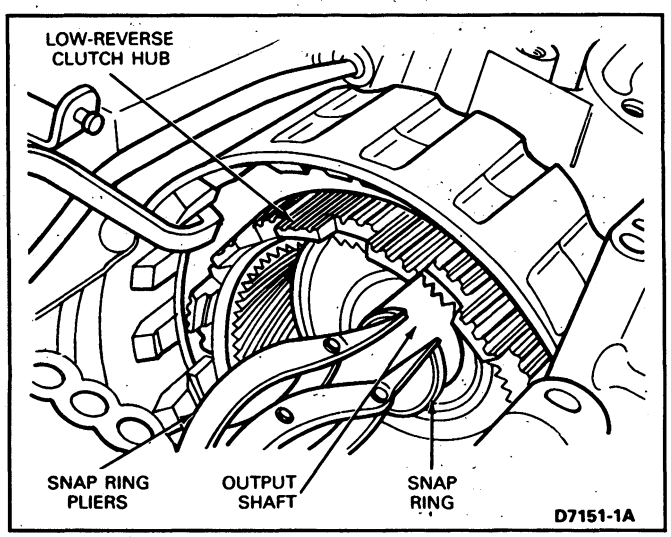


FIG. 22 Removing or Installing Reverse Ring Gear Hub, Snap Ring

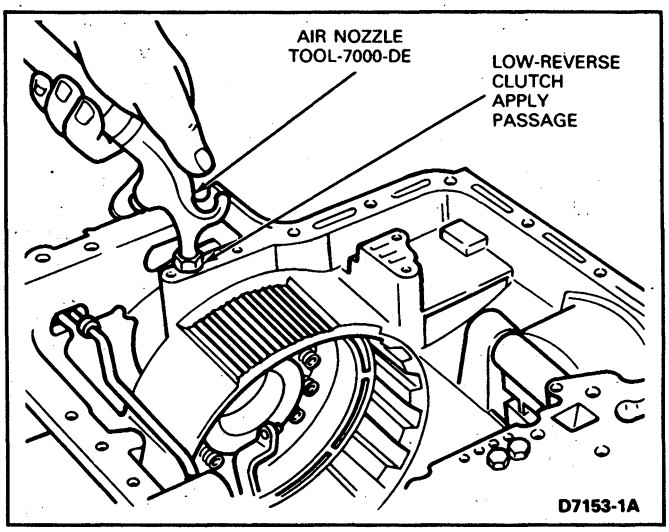


FIG. 23 Removing Low-Reverse Clutch Piston

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16. Install the reverse planet ring gear thrust washer and the ring gear and hub assembly. Insert the snap ring in the groove on the output shaft.
17. Assemble the front and rear thrust washers onto the reverse planet assembly; retain with petroleum jelly. Insert the assembly into the ring gear and install the snap ring.
18. Set the reverse-high clutch assembly on the bench, with the front end facing down. Install the thrust washer on the rear end of the reverse-high clutch assembly. Retain the thrust washer with petroleum jelly and insert the splined end of forward clutch into the open end of the reverse-high clutch with splines engaging the direct clutch friction plates (Fig. 38).
19. Install the thrust washers and retain them with petroleum jelly, on the front end of the forward planet ring gear and hub. Insert the ring gear into the forward clutch.
20. Install the thrust washer on the front end of the forward planet assembly. Retain the washer with petroleum jelly and insert the assembly into the ring gear. Install the input shell and sun gear assembly.
21. Install the reverse-high clutch assembly, forward clutch assembly, forward planet assembly and drive input shell, and sun gear as an assembly into the transmission case.
22. Insert the intermediate band into the case around the reverse-high clutch drum. Install the struts and tighten the band adjusting screw sufficiently to retain the band.
23. Place a selective thickness bronze thrust washer on the rear shoulder of the stator support and retain it with petroleum jelly. If the end play was not within specification when checked prior to disassembly, replace the washer with one of proper thickness. Refer to specifications at the end of this Section for selective thrust washer thicknesses.

    Using two 5/16-inch bolts three inches long, make two alignment studs. Cut the heads from the bolts and grind a taper on the cut end. Temporarily install the two studs opposite each other in the mounting holes of the case. Slide a new gasket onto the studs. Position pump on case, being careful not to damage the large seal on the outside diameter of the pump housing, (removing the aligning studs).

    Install six of the seven mounting bolts and tighten to 22-40 N·m (16-30 ft-lbs).
24. Adjust the intermediate band as detailed under Adjustments and install the input shaft with the long splined end inserted into the forward clutch assembly.
25. Install Tool 4201-C or equivalent at the seventh pump mounting bolt (Fig. 18) and check the transmission end play as in steps 4, 5 and 6 of Disassembly. (See specifications at the end of this Section.) Remove the tool.

    Install the seventh pump mounting bolt and tighten to 22-40 N·m (16-30 ft-lbs).
26. Install the main control valve body on the case, making sure that the levers engage the valves properly and tighten the attaching bolts to 11-14 N·m (95-125 in.-lbs). Install the primary throttle valve, rod, and the vacuum diaphragm in the case. Tighten the diaphragm attaching bolt to 17-21 N·m (12-16 ft-lbs).
27. Install a new pan gasket and the pan. Tighten the bolts to 10.5-17 N·m (8-12 ft-lbs).
28. Install the converter assembly.
29. Install the transmission in the vehicle as detailed under Removal and Installation.

Control Valve Body

Disassembly

The valve body-to-screen gasket should not be cleaned in a degreaser solvent or any type of detergent solution when disassembling the main control. To clean the gasket, wipe it off with a lint-free cloth.

1. Remove the nine screws that attach the screen to the lower valve body (Fig. 24) and remove screen and gasket (Fig. 25).
2. Remove the five upper-to-lower valve body and hold-down plate attaching screws. Remove the seven attaching screws from the underside of the lower valve body (Fig. 24).
3. Separate the bodies and remove the separator plate and gasket. **Be careful not to lose the check valves and springs.** Remove and clean the separator plate screen if necessary (Fig. 25).
4. Remove the manual valve retaining pin from the upper valve body (Fig. 26).
5. Slide the manual valve (Fig. 26) out of the valve body.
6. Cover the downshift valve bore with a finger, then working from the underside of the body remove the downshift valve retainer. Remove the spring and downshift valve (Fig. 26).
7. Apply hand pressure on the pressure boost valve sleeve end and remove the sleeve retaining clip from the under side of the body. Slowly release hand pressure and remove the sleeve and the pressure boost valve. Remove the two springs, the spring and the main regulator valve from the bore.
8. Apply pressure on the throttle boost valve retaining plate and remove the two attaching screws. Slowly release the pressure and remove plate, throttle pressure boost valve and spring, and the manual low 2-1 scheduling valve and spring from the body (Fig. 26).
9. Apply pressure on the remaining valve retaining plate and remove the eight attaching screws.
10. Hold the valve body so that the plate is facing upward. Slowly release the pressure and remove the plate.
11. Remove the spring and the intermediate servo modulator valve (Fig. 26) from the valve body.
12. Remove the intermediate servo accumulator valve and springs.
13. Remove the 2-3 back-out valve and spring.
14. Remove the 2-3 shift valve, spring and the throttle modulator valve and spring.
15. Remove the 1-2 shift valve, DR-2 shift valve and the spring from the valve body.

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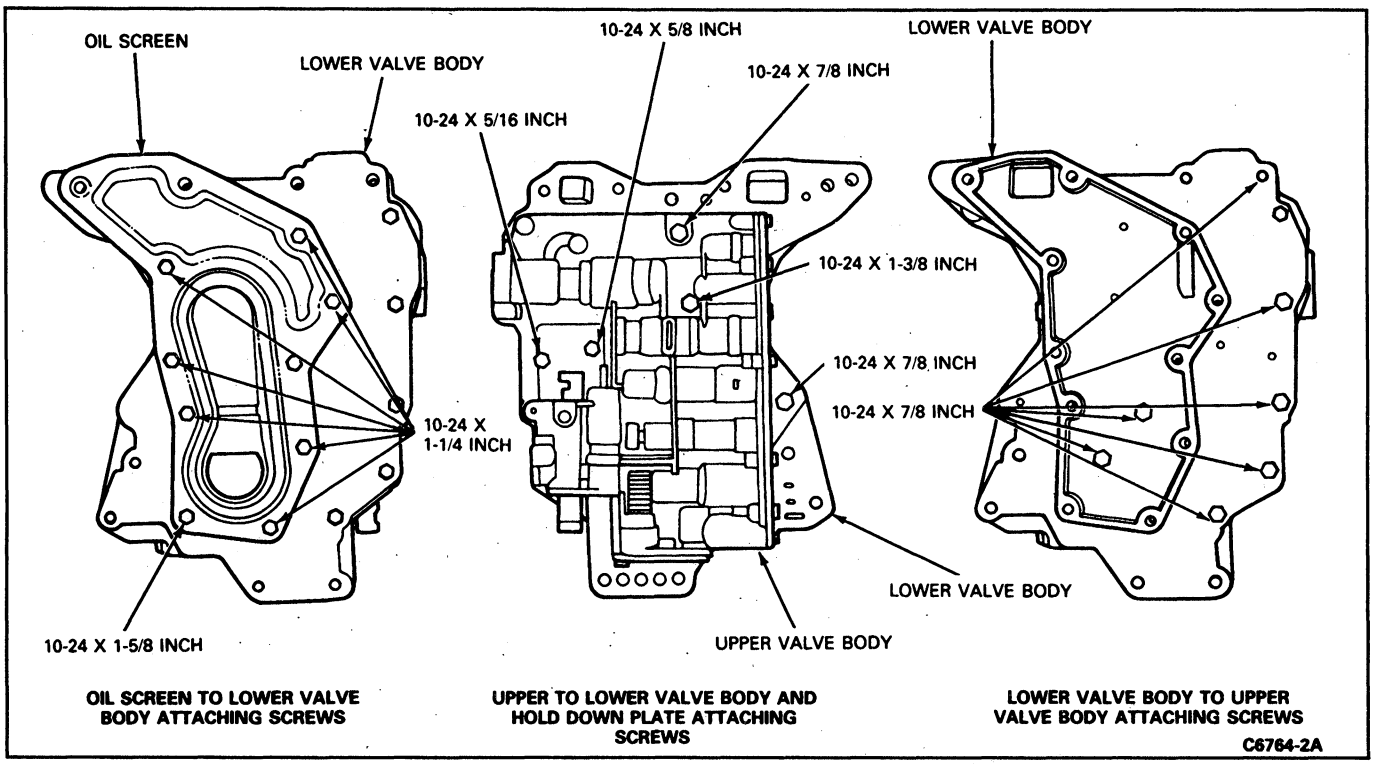


FIG. 24 Control Valve Body and Screen Attaching Screws

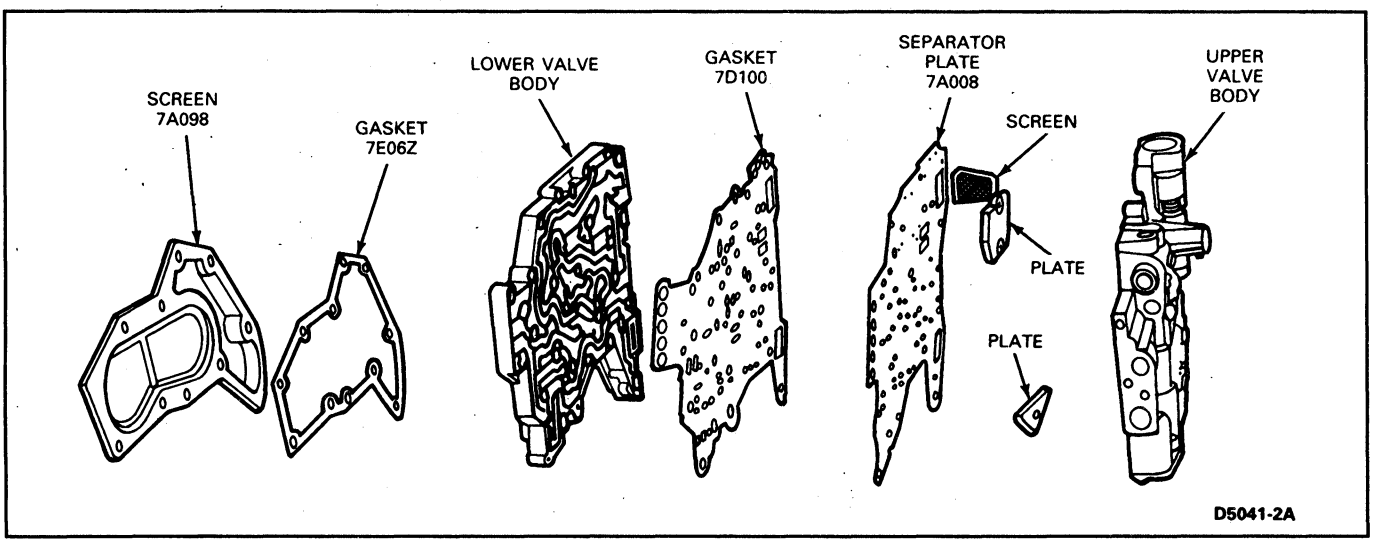


FIG. 25 Upper and Lower Valve Bodies Disassembled

16. Remove the line pressure coasting regulator valve, (Fig. 26) from the body.
17. Remove the cutback control valve to complete the disassembly of the control valve.

Assembly

1. Place the downshift valve and spring in the valve body. Compress the spring and install the retainer from the underside of the body (Fig. 27).
2. Place the valve body on a clean surface with the passage side facing up. Place the converter relief valve spring in its bore (Fig. 27). Coat the converter pressure relief valve with petroleum jelly and place it on top of the spring. Place the 2-3 shift valve check ball in its cavity. Place the throttle pressure relief valve spring in its bore (Fig. 27). Coat the throttle pressure relief valve check ball with petroleum jelly and place it on top of the spring. Place the reverse clutch check ball in its cavity.
3. Install the separator screen in the separator plate if it was previously removed. **Be sure the screen tabs are flush with the separator plate surface.** Carefully position the separator plate and new gasket on the lower valve body. Place the two hold-down plates on the separator plate and install the attaching screws finger tight.
4. Place the lower body and plate assembly on the upper valve body (Fig. 24) and install the attaching screws finger tight.

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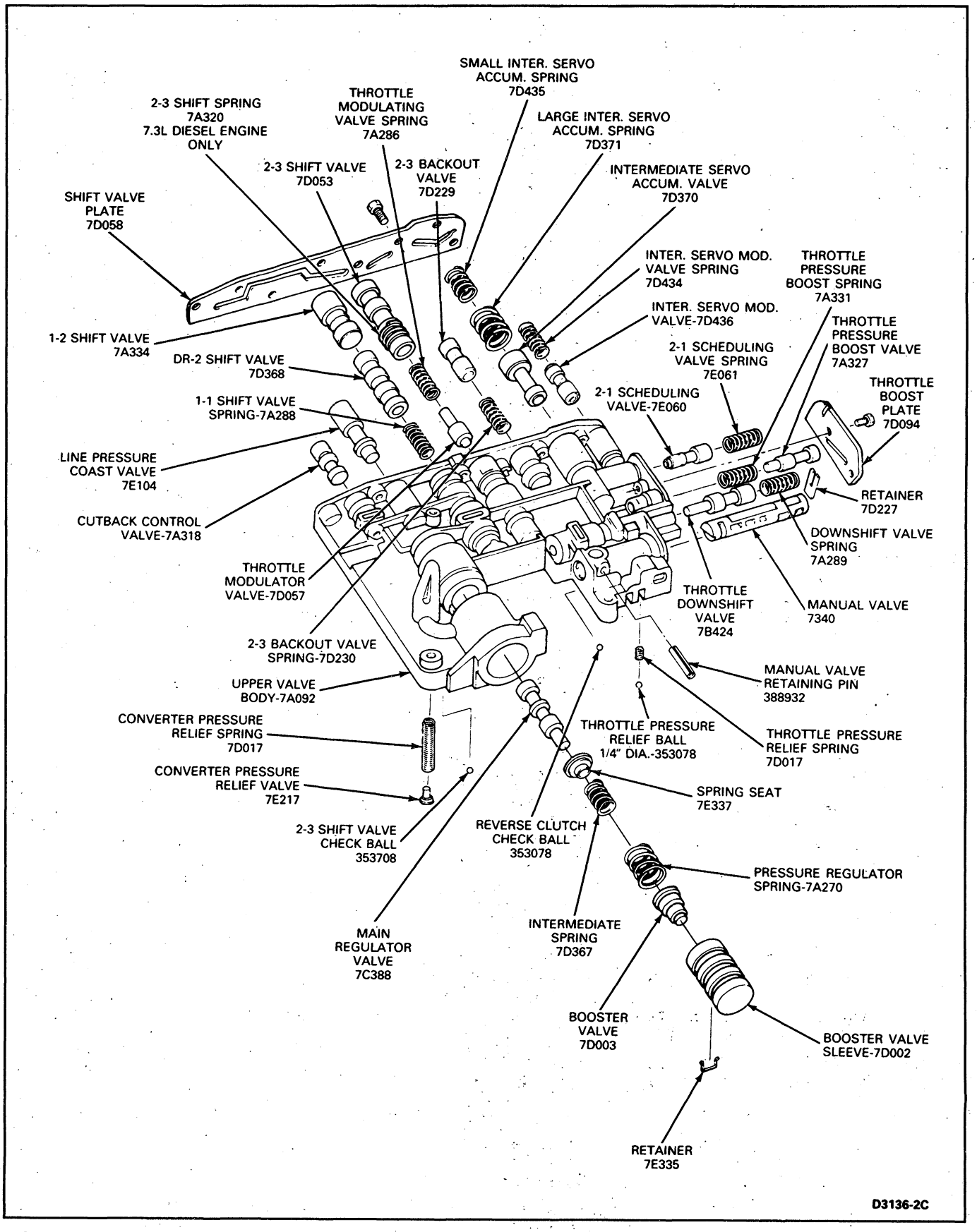


FIG. 26 Upper Valve Body Disassembled

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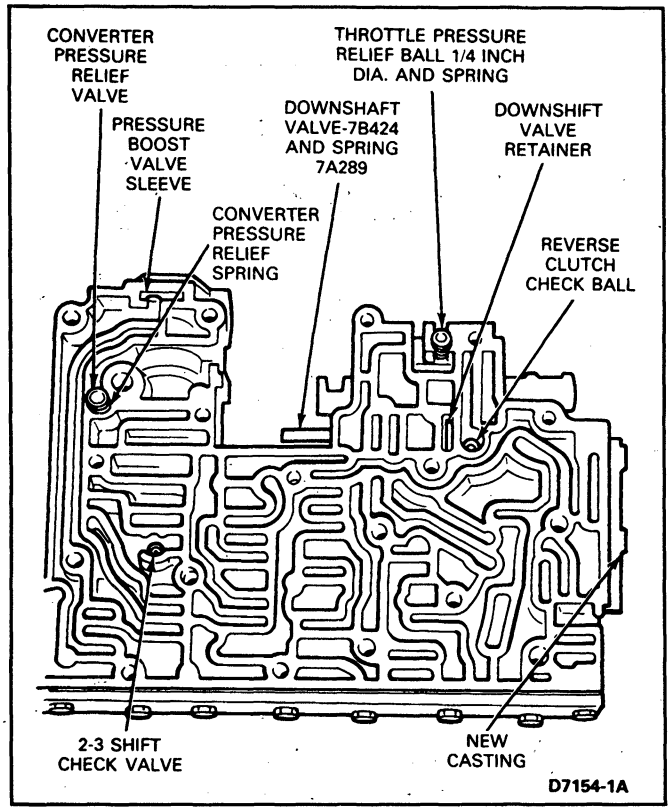


FIG. 27 Downshift Valve and Spring, Converter Pressure Relief Valve, Throttle Pressure Relief Valve Check Ball, and 2-3 Shift Check Valve Locations

5. Install the oil screen screws loosely, without the screen, to properly align the upper and lower valve bodies, gasket and separator plate.
6. Tighten the two bolts that are covered by the screen to 5.0-6.2 N·m (40-55 in.-lbs).
7. Remove the oil screen attaching screws and place the gasket and oil screen in position on the lower valve body. Re-install the screen attaching screws (Fig. 24).
8. Tighten all the valve body and screen attaching screws to 5.0-6.2 N·m (40-55 in.-lbs).
9. Place the cutback control valve (Fig. 26) and the line pressure coasting regulator valve in the valve body.
10. Place the one spring, DR-2 shift valve and the 1-2 shift valve in the body.
11. Place the throttle modulator valve and spring and the 2-3 shift valve (and spring on 7.3L Diesel) in the valve body.
12. Place the spring and the 2-3 backout valve in the valve body.
13. Place the two springs and the intermediate servo accumulator valve in the valve body.
14. Place the intermediate servo modulator valve and spring in the body.
15. Carefully place the valve retaining plate on the body and secure it with the eight attaching screws. Tighten the two hex washer head screws to 2.5-5.0 N·m (20-45 in-lbs). Tighten the remaining six screws to 2.5-4.5 N·m (20-40 in-lbs).
16. Place the throttle pressure boost valve and spring in the valve body. Place the manual low 2-1 scheduling valve and spring in the valve body and install the retaining plate. Tighten the attaching screws to 2.5-5.0 N·m (20-45 in.-lbs).
17. Place the spring seat on the stem of the main regulator valve so that the retainer flange is next to the valve shoulder. Place the main regulator valve, spring seat, two springs, pressure boost valve and sleeve in the bore. Apply hand pressure on the end of the pressure boost valve sleeve and install the spring clip retainer in the groove on the under side of the body so that the clip is inserted into the end groove in the sleeve. Be sure that the pressure boost valve sleeve is free in its bore.
18. Place the manual valve in the valve body and install the retaining pin in the body.

Intermediate Servo

(Refer to Fig. 10).

Disassembly

1. Apply air pressure to the port in the servo cover to remove the piston and rod.
2. Replace the complete piston and rod assembly if the piston or piston sealing lips are unserviceable or damaged.
3. Remove the seal and gasket from the cover.

Assembly

1. Dip the new seals in transmission fluid.
2. Install new seal and gasket on the cover.
3. Dip the piston in transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H), or equivalent and install it in the cover.

Governor

Disassembly

1. Remove the governor body attaching bolts and remove the governor.
2. Remove and discard the snap ring that secures the governor oil collector body on the output shaft (Fig. 28) and slide the governor off the front of the shaft.
3. Remove the seal rings from the oil collector body.

Assembly

1. Carefully install new seal rings on the oil collector body.
2. Working from the front end of the output shaft, slide the governor oil collector body into place on the shaft. Install a new snap ring to secure it. Make sure that the snap ring is seated in the groove.
3. Position the governor assembly on the oil collector body (Fig. 28) and secure with the attaching screws. Tighten screws to 10.5-13.5 N·m (90-120 in.-lbs).

Downshift and Manual Linkage

Disassembly

1. Remove the nut and lockwasher that secures the outer downshift lever to the transmission and remove the lever.

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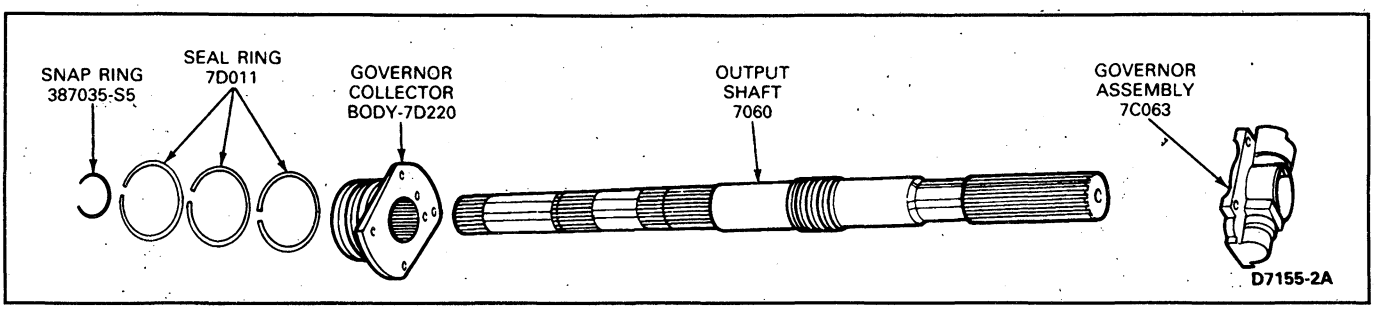


FIG. 28 Output Shaft Disassembled

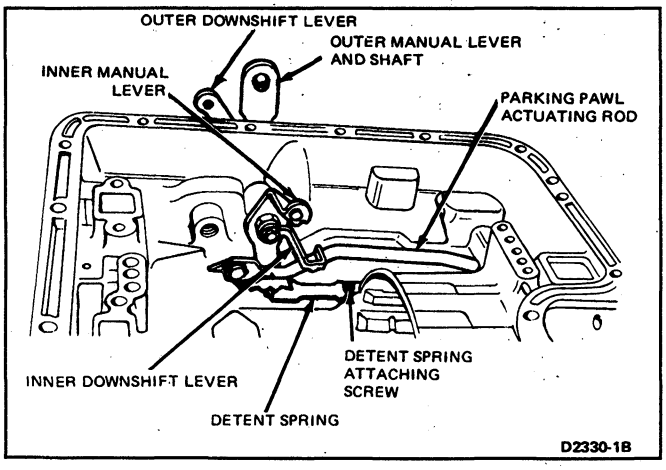


FIG. 29 Downshift and Manual Linkage

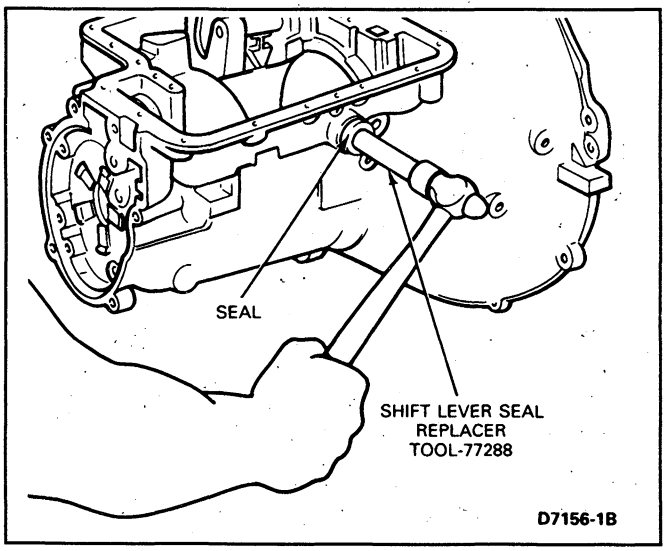


FIG. 30 Installing Manual Lever Seal

2. Slide the inner downshift lever assembly out from the inside of the case (Fig. 29). Remove the seal from the recess in the manual lever shaft.
3. Remove the two bolts retaining the neutral start switch, and remove the switch, (Fig. 6).
4. Remove the C-ring securing the parking pawl actuating rod to the manual lever. Remove the rod from the case.
5. Remove the nut securing the inner manual lever to the shaft. Remove the inner lever from the shaft. Slide the outer lever and shaft from the case.

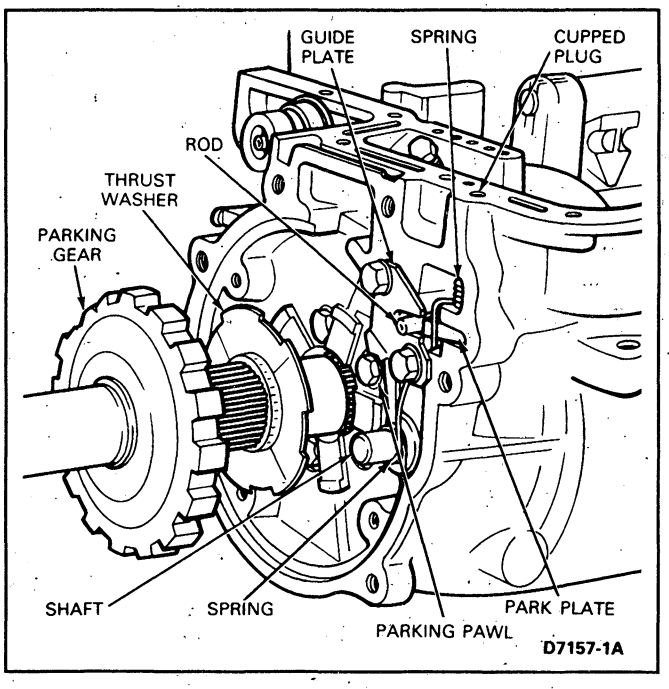


FIG. 31 Parking Pawl Mechanism

6. Remove the seal from the case with Tools T59L-100-B, Slide Hammer and T58L-101-B, Puller Attachment, or equivalents.

Assembly

1. Dip the new seal in transmission fluid Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H), or equivalent and install it in the case using TOOL-77288 or equivalent as shown in Fig. 30.
2. Slide the outer manual lever and shaft in the transmission case.
3. Position the inner lever on the shaft, making sure the leaf spring roller is positioned in the inner manual lever detent. Install the attaching nut. Tighten the nut to 41-54 N·m (30-40 ft-lbs). Install the parking pawl actuating rod and secure it to the inner manual lever with a C-ring.
4. Slide the neutral-start switch on the outer lever shaft and install the bolts in the case.
5. With the transmission manual lever in neutral, rotate the switch and install the gauge pin (No. 43 drill) into the gauge pin hole aligning all three holes (Fig. 6). Tighten the bolts to 6.5-8.0 N·m (55-75 in.-lbs).

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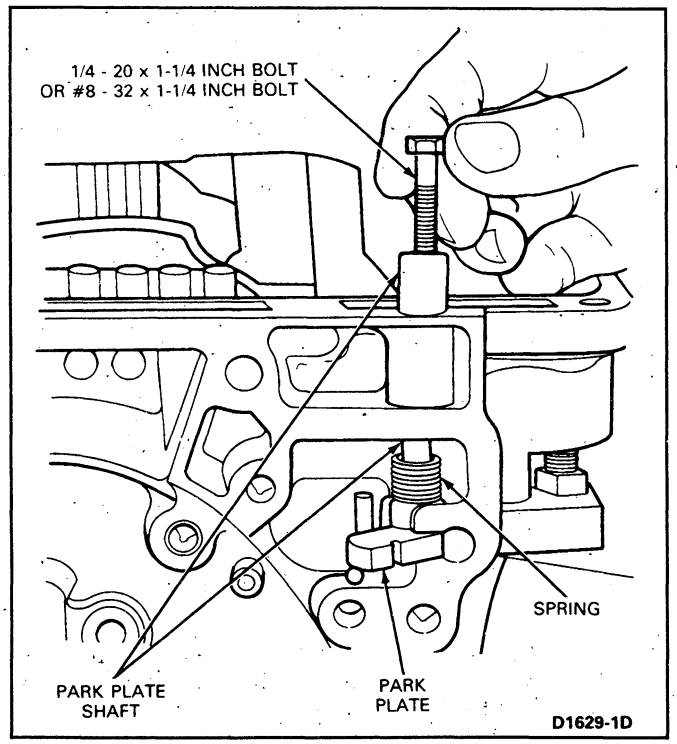


FIG. 32 Removing Park Plate

6. Install a new downshift lever seal in the recess of the outer lever shaft. Slide the downshift lever and shaft into position.
7. Place the outer downshift lever on the shaft and secure it with a lockwasher and nut. Tighten nut to 17-21 N·m (12-16 ft-lbs).

Parking Pawl Linkage

Disassembly

1. Remove the bolts securing the parking pawl guide plate to the case (Fig. 31). Remove the plate.
2. Remove the spring, parking pawl and shaft from the case.
3. Working from the pan mounting surface, drill a 1/8 inch diameter hole through the center of the cupped plug. Pull the plug from the case with a wire hook.
4. Unhook the end of the spring from the park plate slot to relieve the tension.
5. Thread a 1/4-20 inch or 8-32 x 1-1/4 inch screw (Fig. 32) into the park plate shaft. Pull the shaft from the case with the screw. Remove the spring and park plate.

Assembly

1. Position the spring and park plate in the case and install the shaft. Place the end of the spring into the slot of the park plate.
2. Install a new cupped plug to retain the shaft.
3. Install the parking pawl shaft in the case. Slip the parking pawl and spring into place on the shaft.
4. Position the guide plate on the case, making sure that the actuating rod is seated in the slot of the plate. Secure the plate with two bolts and lockwashers. Tighten bolts to 17-21 N·m (12-16 ft-lbs).

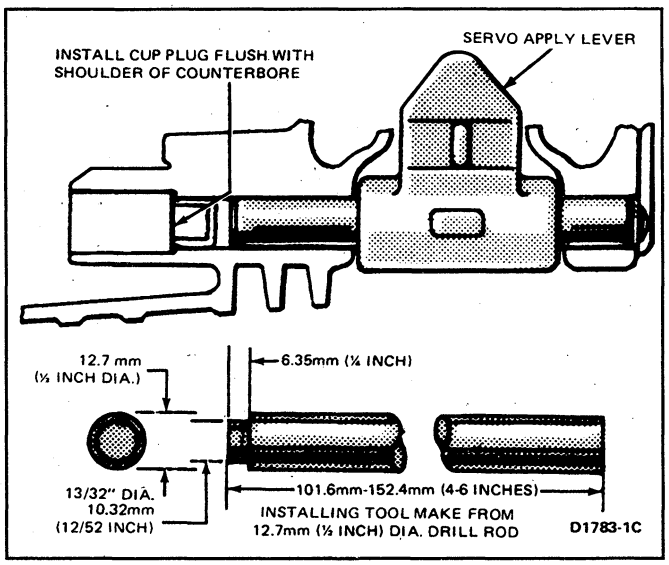


FIG. 33 Servo Apply Lever Installation

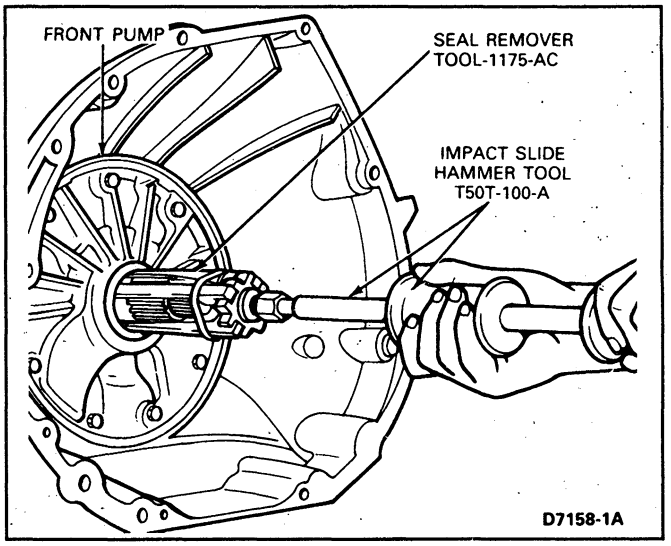


FIG. 34 Removing Front Pump Seal

Servo Apply Lever

Disassembly

1. Working from inside of the transmission case, carefully drive on the servo apply lever shaft to remove the cup plug. The shaft (Fig. 33) can be withdrawn from the case by hand.

Assembly

1. Hold the servo apply lever in position and install the new shaft.
2. Using the fabricated tool shown in Fig. 33, drive the cup plug into position in the case. Be sure the plug is flush with the shoulder of the counterbore. The cup plug may be coated with Threadlock and Sealer, EOAZ-19554-AA (ESE-M4G204-A) or equivalent, before installation.

Front Pump

The front seal can be replaced after the pump has been installed on the transmission using T50T-100-A and TOOL-1175-AC or equivalent for removal, and

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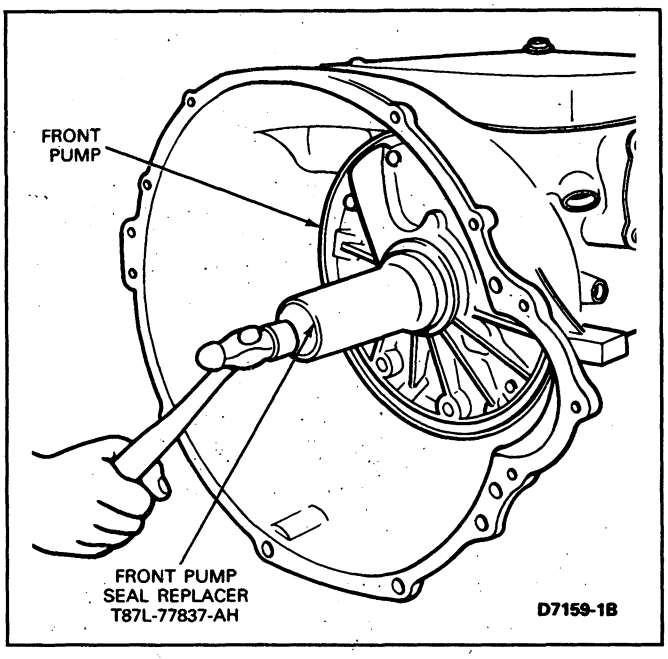


FIG. 35 Installing Front-Pump Seal

T87L-77837-AH or equivalent for installation (Figs. 34 and 35).

Disassembly

1. Remove the two seal rings and the selective thrust washer (Fig. 36).
2. Remove the large square-cut seal from the outside diameter of the pump housing.
3. Remove the five bolts that secure the stator support to the pump housing. Lift the support from the housing.
4. Remove the drive and the driven gear from the housing.
5. If the pump housing bushing is worn or damaged, replace it using the handle and Tool T66L-7003-C2 or equivalent shown in Fig. 37.

   Place the new bushing in position, making sure the half moon slot in the bushing is on top and in line with the oil lube hole near the seal bore. Press the bushing in 1.52-2.03mm (0.060-0.080 inch) below the front face of the bushing bore. Use Tool T66L-7003-C2 or equivalent and handle to seat the bushing properly. After assembly, the half moon slot must be in past the lube hole to provide proper lubrication.

Assembly

1. Install the drive and driven gears in the pump housing. **Each gear has either an identification mark or chamfered teeth on one face. The identification mark or the chamfered surface on each gear must be installed toward the front of the pump housing.**
2. Position the stator support in the pump housing and install the five attaching bolts. Tighten bolts to 17-21 N·m (12-16 ft-lbs).
3. Carefully install two new seal rings on the stator support. Make sure that the ends of the rings are engaged to lock them in place. Install a new square-cut seal on the outside diameter of the pump housing.
4. Install the selective thrust washer. **Make sure that the correct thickness selective washer is being used to obtain the specified end play.** Refer to Specifications at end of this Section.
5. Place the pump on the converter, making sure that the drive gear engages the converter hub. Rotate the pump to make sure that the gears rotate freely.

Reverse-High Clutch

Disassembly

1. Separate the drive train as shown in Fig. 38. Remove the pressure plate snap ring as shown in Fig. 39.
2. Remove the pressure plate and the drive and driven (internal and external spline) clutch plates (Fig. 40).
3. Install Clutch Spring Compressor, Tool T65L-77515-A (Fig. 41) on the reverse-high clutch drum. Make sure that the legs clear the snap ring enough to remove it. Remove the snap ring and remove the tool.

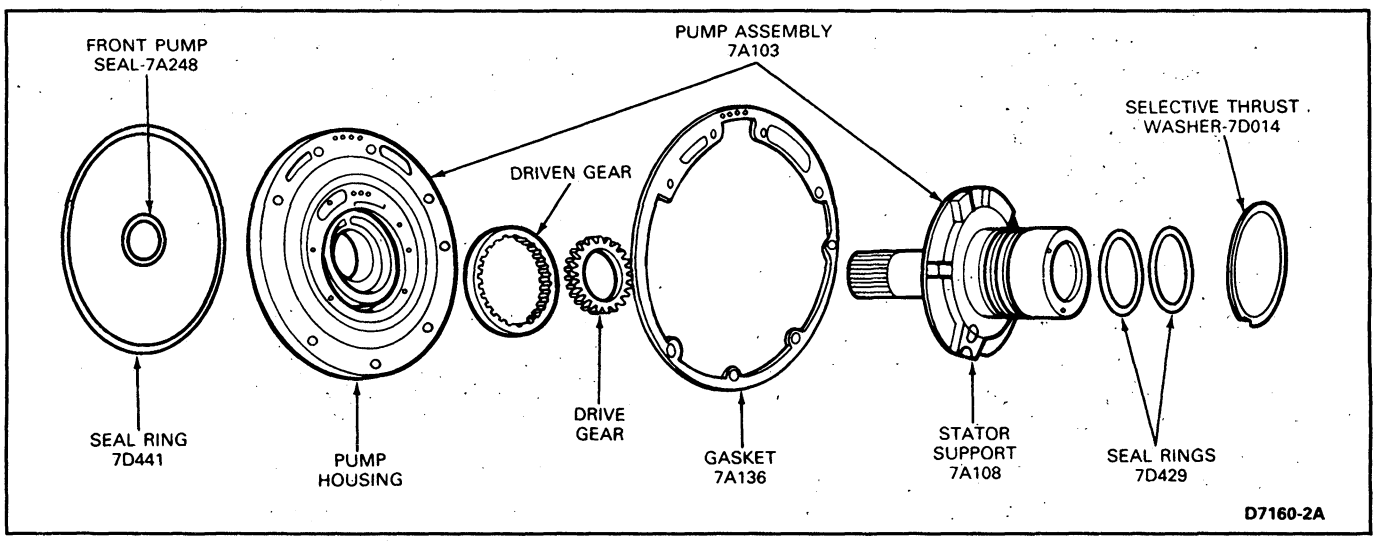


FIG. 36 Front Pump Disassembled

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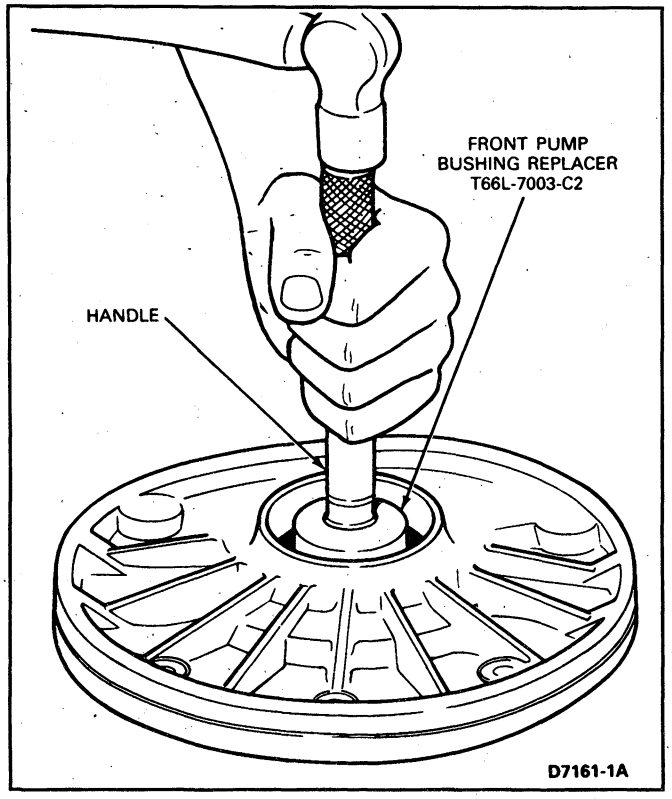


FIG. 37 Replacing Front Pump Housing Bushing

4. Remove the spring retainer and the piston return springs.
5. Apply air pressure to the piston apply hole in the clutch hub using TOOL-7000-DE or equivalent (Fig. 42) and remove the piston.
6. Remove the piston outer seal from the piston and the inner seal from the clutch drum (Fig. 40).
7. Remove the front and rear bushings from the clutch drum if they are worn or damaged. To remove the front bushing, use a cape chisel and cut along the bushing seam until the chisel breaks through the bushing wall. Pry the loose ends of the bushing up with an awl and remove the bushing. To remove the rear bushing, use Tool T69L-7D044-B or equivalent shown in Fig. 43, and press the bushing from the drum.

Assembly

1. If the clutch drum bushings were removed, position the drum in a press and press new bushings into the drum with the Tool T69L-7D044-B or equivalent shown in Figs. 43 and 44.
2. Dip the new seals in transmission fluid and install one on the drum and one on the piston.
3. Install the piston in the clutch drum.
4. Position the piston return springs in the piston sockets (Fig. 45). Place the spring retainer on the springs.
5. Install Clutch Spring Compressor, Tool T65L-77515-A (Fig. 41) and compress the springs. Make certain that the spring retainer is centered while compressing the springs. Install the snap ring. **Before releasing the pressure on the tool, make certain that the snap ring is positioned inside of the four snap ring guides on the spring retainer.**
6. Clutch plate usage varies with each model, refer to the specifications at end of this Section for the number of plates required. Dip the clutch plates in clean transmission fluid. Install the clutch plates alternately starting with a steel drive (internal) plate (Fig. 40). When new composition clutch plates are used, soak the plates in automatic transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent, for 15 minutes before they are assembled.
7. After all clutch plates have been installed, position the pressure plate in the clutch drum. Install the pressure plate (selective) snap ring.
8. With a feeler gauge, check the clearance between the pressure plate and snap ring (Fig. 46).
9. The pressure plate should be held downward as the clearance is checked. The clearance should be 0.558-0.914mm (0.022-0.036 inch). If the clearance is not within specifications, selective thickness snap rings are available in the following thicknesses: 1.42-1.52mm (0.056-0.060 inch), 1.65-1.75mm (0.065-0.069 inch), 1.87-1.98mm (0.074-0.078 inch), 2.10-2.20mm (0.083-0.087 inch), 2.33-2.43mm (0.092-0.096 inch), 2.79-2.89mm (0.110-0.114 inch) and 3.25-3.35mm (0.128-0.132 inch). Install the correct size snap ring and re-check the clearance.

Forward Clutch

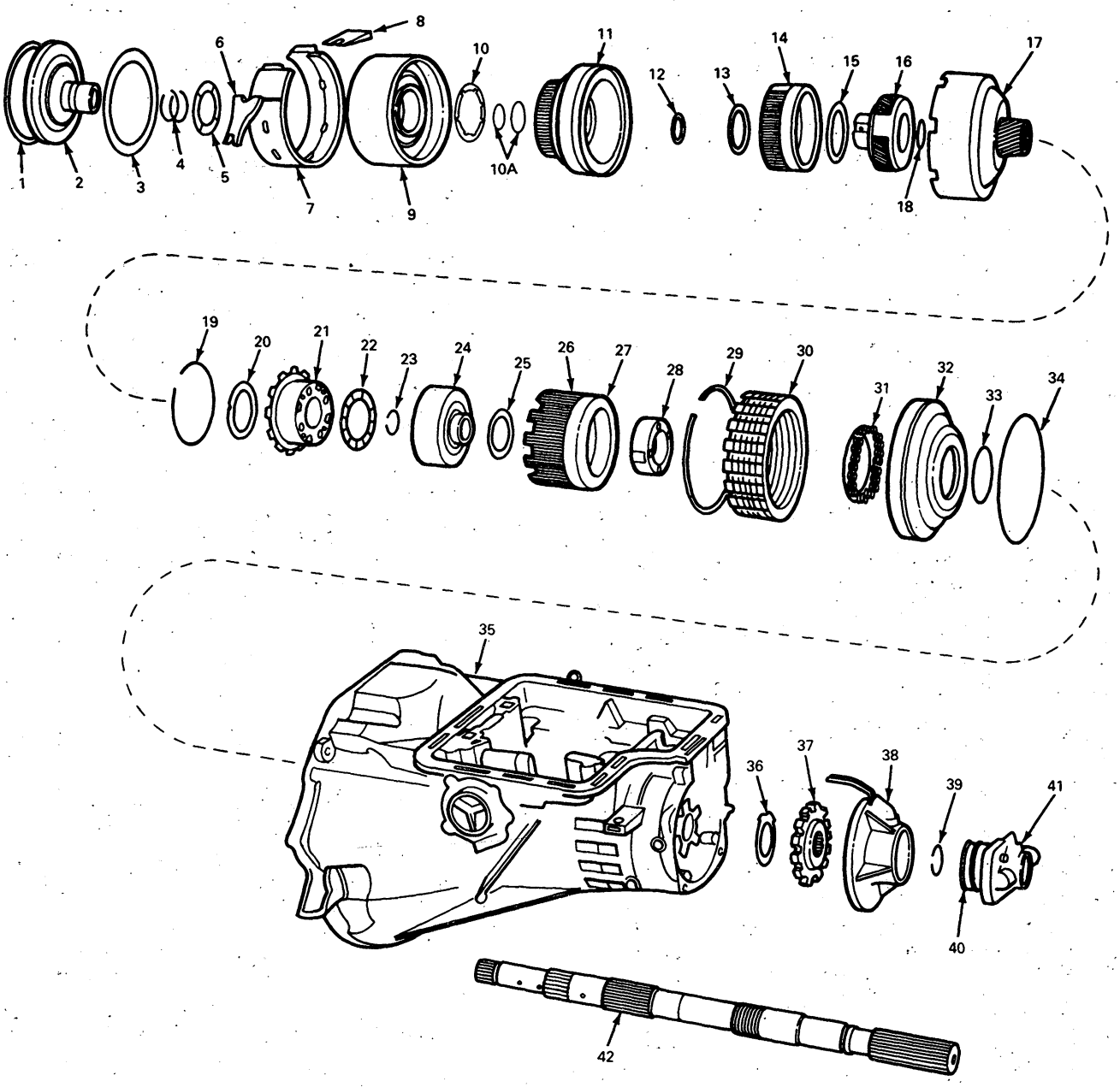
Disassembly

1. Remove the clutch pressure plate snap ring (Fig. 47).
2. Remove the rear pressure plate, the drive and driven plates, wave plate, and the forward pressure plate from the clutch hub (Fig. 48).
3. Remove the snap ring (Fig. 49) that secures the disc spring in the clutch cylinder. Remove the disc spring and steel ring using Tool T65L-77515-A.
4. Apply air pressure to the clutch cylinder using TOOL-7000-DE or equivalent (Fig. 50) to remove the piston.
5. Remove the seal from the piston and the seal from the clutch hub (Fig. 48).

Assembly

1. Dip two new seals in transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent. Install the smaller seal on the clutch hub and the lip seal on the clutch piston.
2. Install the clutch piston and lip seal with Lip Seal Protector, T77L-77548-A, (Fig. 51).
3. Position the installation tool into the forward clutch cylinder, so that the bore of the tool is aligned with the piston bore in the cylinder. Press the piston into the cylinder until it bottoms in the bore. Remove the installation tool.
4. Make sure that the steel pressure ring is in the groove on the piston. **Position the disc spring in the cylinder with the dished face downward.** Install the spring as shown in Fig. 49 so that the

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1. FRONT PUMP SEAL RING-7D441
2. FRONT PUMP-7A103
3. GASKET-7A136
4. SEAL RINGS
5. NUMBER 1 THRUST WASHER (SELECTIVE)
6. STRUT INTERMEDIATE BRAKE BAND-7D029
7. INTERMEDIATE BRAKE BAND ASSEMBLY-7D029
8. STRUT INTERMEDIATE BRAKE BAND ANCHOR-7D430
9. REVERSE-HIGH CLUTCH ASSEMBLY
10. NUMBER 2 THRUST WASHER
10A. FORWARD CLUTCH SEAL RINGS
11. FORWARD CLUTCH ASSEMBLY
12. NUMBER 3 THRUST WASHER NEEDLE BEARING
13. NUMBER 4 THRUST WASHER
14. FORWARD PLANET RING AND HUB ASSEMBLY-7D392
15. NUMBER 5 THRUST WASHER
16. FORWARD PLANET ASSEMBLY 7A298
17. INPUT SHELL-7D064 AND SUN GEAR ASSEMBLY-7D063
18. NUMBER 6 THRUST WASHER NEEDLE BEARING
19. SNAP RING
20. NUMBER 7 THRUST WASHER
21. REVERSE PLANET ASSEMBLY 7D006
22. NUMBER 8 THRUST WASHER
23. REVERSE RING GEAR AND HUB RETAINING RING
24. REVERSE RING GEAR-7A153 AND HUB-7D164
25. NUMBER 9 THRUST WASHER
26. LOW-REVERSE CLUTCH HUB 7B067
27. ONE-WAY CLUTCH-7A089
28. ONE-WAY CLUTCH INNER RACE 7D171
29. SNAP RING
30. LOW-REVERSE CLUTCH PLATES
31. LOW-REVERSE PISTON RETURN SPRING AND RETAINER-7D406
32. LOW-REVERSE PISTON-7D402
33. INNER SEAL
34. OUTER SEAL
35. CASE-7005
36. NUMBER 10 THRUST WASHER
37. PARKING GEAR-7A223
38. GOVERNOR DISTRIBUTOR SLEEVE-7C232
39. SNAP RING
40. GOVERNOR COLLECTOR-7D220
41. GOVERNOR-7C063
42. OUTPUT SHAFT-7060

D3138-2C

FIG. 38 Drive Train Disassembled—Typical

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pressure ring and spring are in contact. Secure the disc with the retaining snap ring.

5. Install the forward pressure plate with the flat side up and the beveled side downward. Dip the clutch plates in clean transmission fluid (Specification Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent). Next, install the wave plate, then a steel plate and a composition driven plate. Install the remaining plates in this sequence (Fig. 48).

   Refer to the Specification at end of this Section for the number of plates required. The last plate installed will be the rear pressure plate. Install the snap ring and make certain that it seats fully in the groove.

6. With a feeler gauge, check the clearance between the snap ring and the pressure plate (Fig. 52). Downward pressure on the plate should be maintained when making this check. Clearance should be 0.533-1.168mm (0.021-0.046 inch).

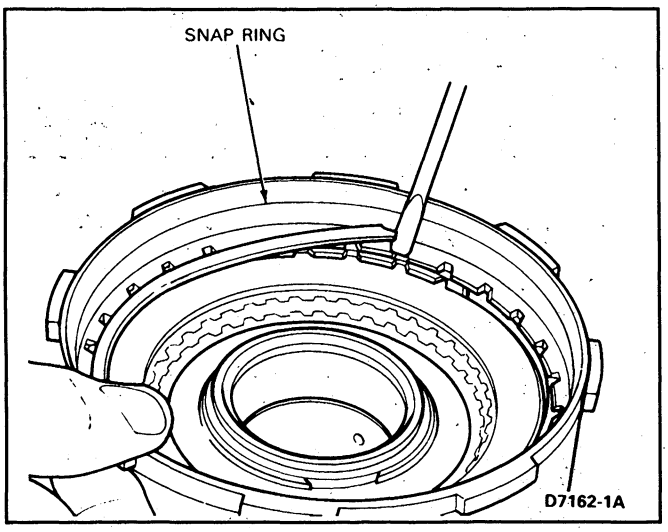


FIG. 39 Removing or Installing Reverse-High Clutch Pressure Plate Snap Ring

7. If the clearance is not within specifications, selective snap rings are available in the following thicknesses: 1.42-1.52mm (0.056-0.060 inch), 1.65-1.75mm (0.065-0.069 inch), 1.87-1.98mm (0.074-0.078 inch), 2.10-2.20mm (0.083-0.087 inch), 2.33-2.43mm (0.092-0.096 inch), 2.79-2.89mm (0.110-0.114 inch) and 3.25-3.35mm (0.128-0.132 inch). Insert the correct size snap ring and recheck the clearance.

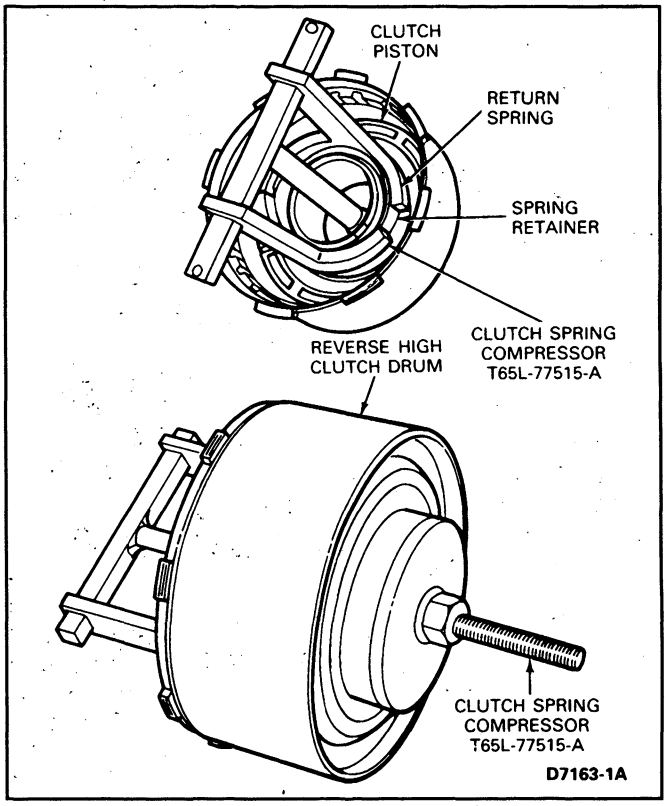


FIG. 41 Removing or Installing Reverse—High Clutch Piston Snap Ring

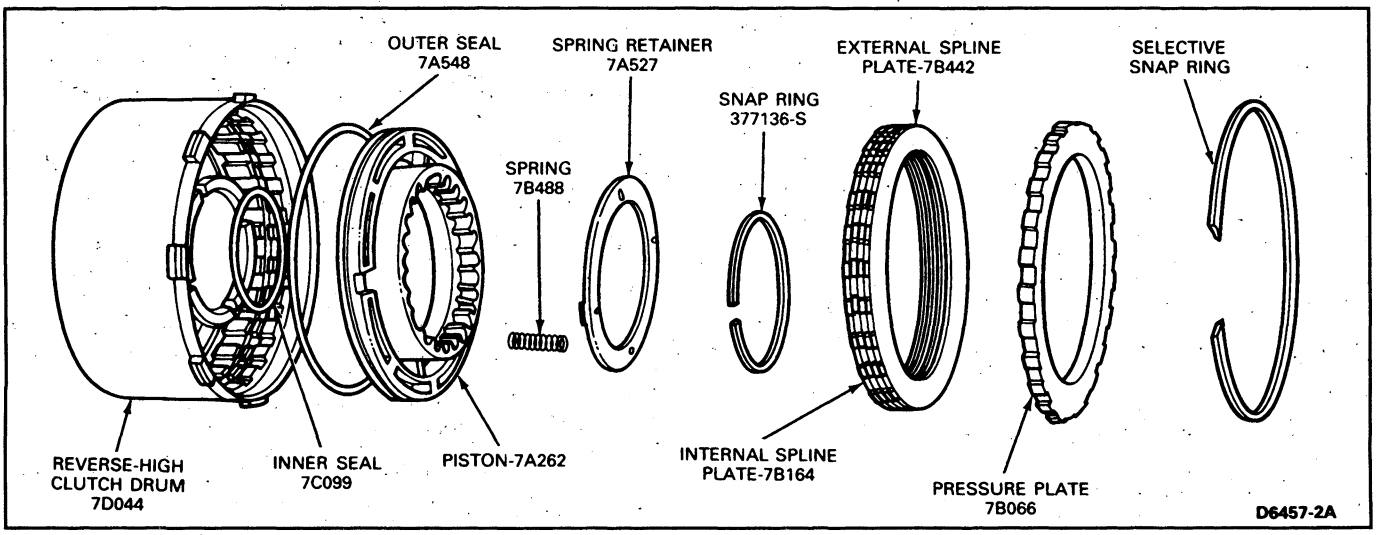


FIG. 40 Reverse-High Clutch Disassembled

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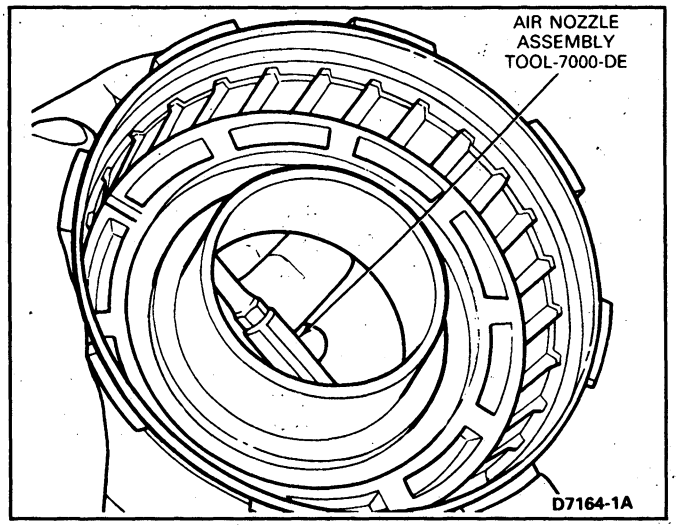


FIG. 42 Removing Reverse-High Clutch Piston

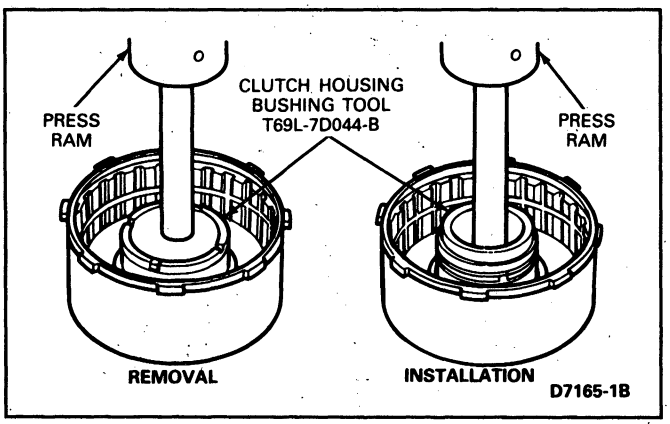


FIG. 43 Replacing Reverse-High Clutch Rear Bushing

Input Shell and Sun Gear

Disassembly

1. Remove the rear snap ring from the sun gear as shown in Fig. 53.
2. Remove the thrust washer wear plate from the input shell and sun gear (Fig. 54).
3. Working from inside the input shell remove the sun gear. Remove the snap ring from the gear.

Assembly

1. Install the forward snap ring on the forward end (short end) of the sun gear (Fig. 54). Working from inside the input shell, slide the sun gear and snap ring into place making sure that the longer end is at the rear (Fig. 54).
2. Place the thrust washer wear plate on the sun gear and install the rear snap ring.

Output Shaft Hub and Ring Gear

Disassembly

1. Remove the hub snap ring (Fig. 55) from the ring gear.
2. Lift the hub from the ring gear.

Assembly

1. Position the hub in the ring gear.

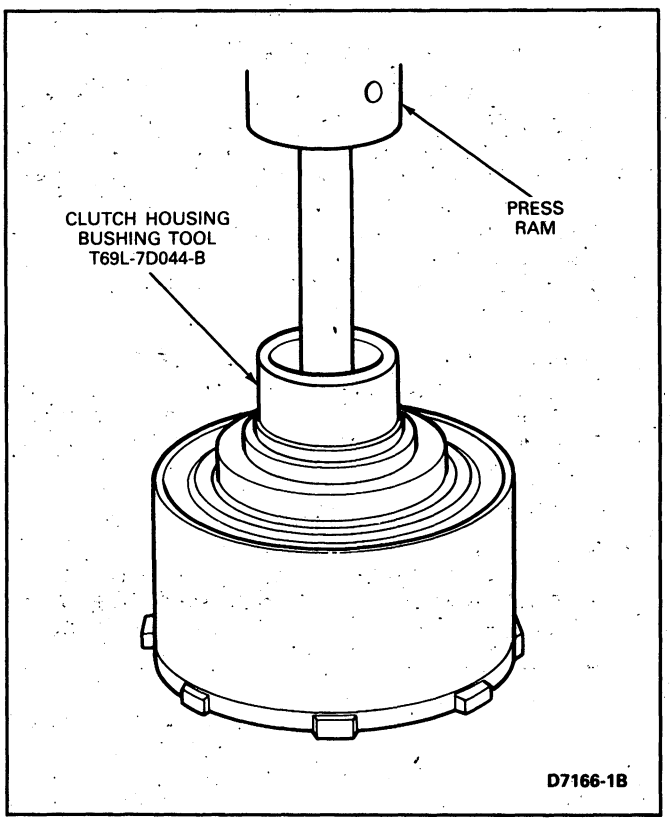


FIG. 44 Installing Reverse-High Clutch Front Bushing

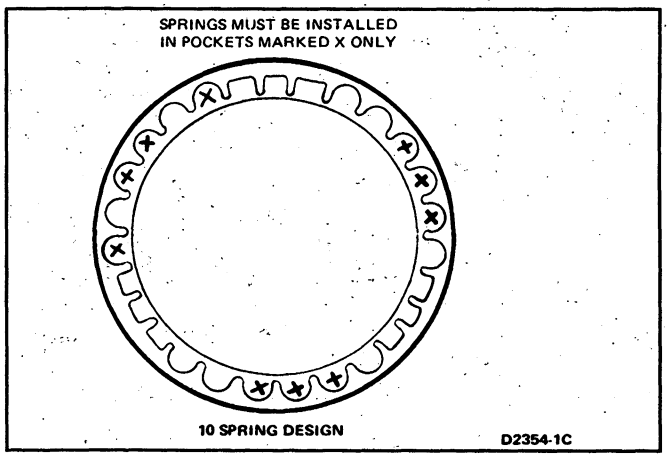


FIG. 45 Reverse-High Clutch Piston Return Spring Locations

2. Secure the hub with the snap ring. Make certain that the snap ring is fully engaged with the groove.

One-Way Clutch

Disassembly

1. Remove the snap ring and bushing from the rear of the low-reverse clutch hub (Fig. 56).
2. Remove the rollers from the spring assembly and lift the spring assembly from the hub.
3. Remove the remaining snap ring from the hub.

Assembly

1. Install a snap ring in the forward snap ring groove of the low-reverse clutch hub.

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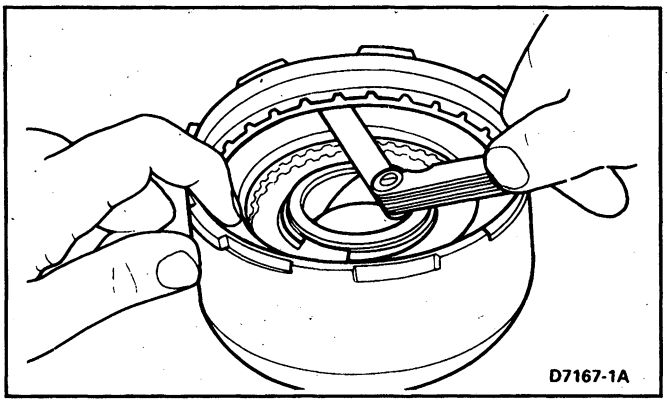


FIG. 46 Checking Reverse-High Clutch Snap Ring Clearance

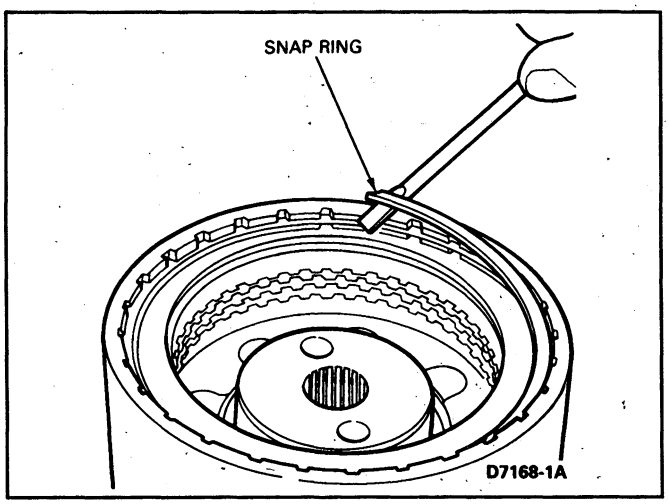


FIG. 47 Removing Forward Clutch Pressure Plate Snap Ring

2. Place the low-reverse clutch hub on the bench with the forward end down (Fig. 57).
3. Install the one-way clutch spring assembly on top of the snap ring.
4. Install a roller into each of the spring assembly compartments (Fig. 56).
5. Install the bushing on top of the spring assembly.
6. Install the remaining snap ring at the rear of the low-reverse clutch hub to secure the assembly (Fig. 56).

Low-Reverse Clutch Piston

Disassembly

1. Remove the inner and the outer seal from the low-reverse clutch piston (Fig. 38).

Assembly

1. Dip the two new seals in clean transmission fluid, Motorcraft MERCON® Multi-purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent.
2. Install the seals on the piston.

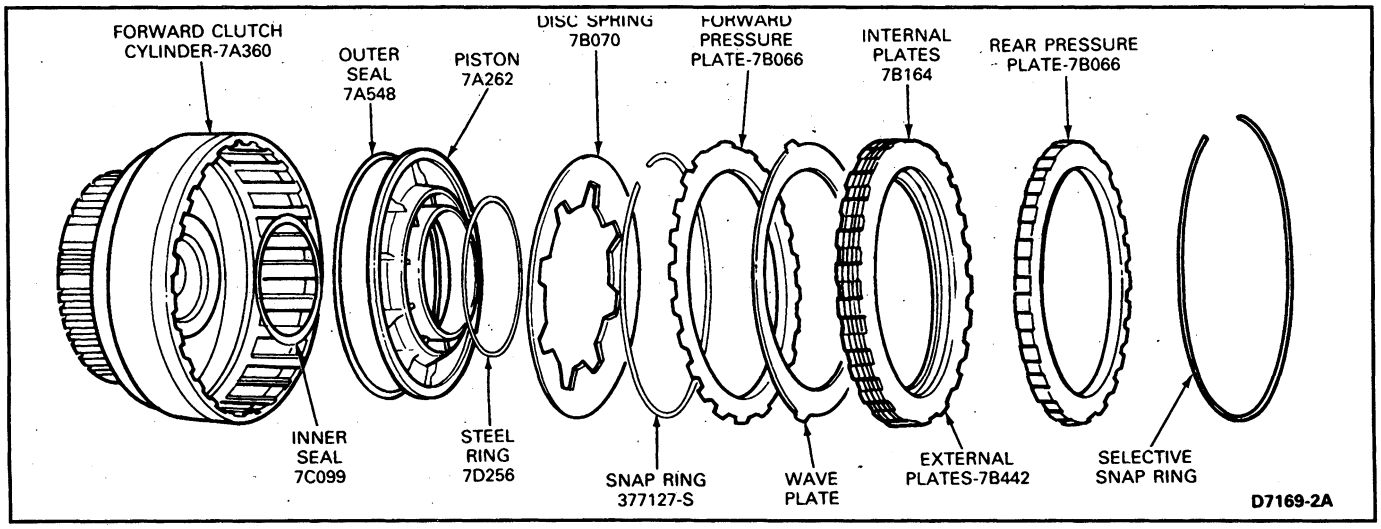


FIG. 48 Forward Clutch Disassembled

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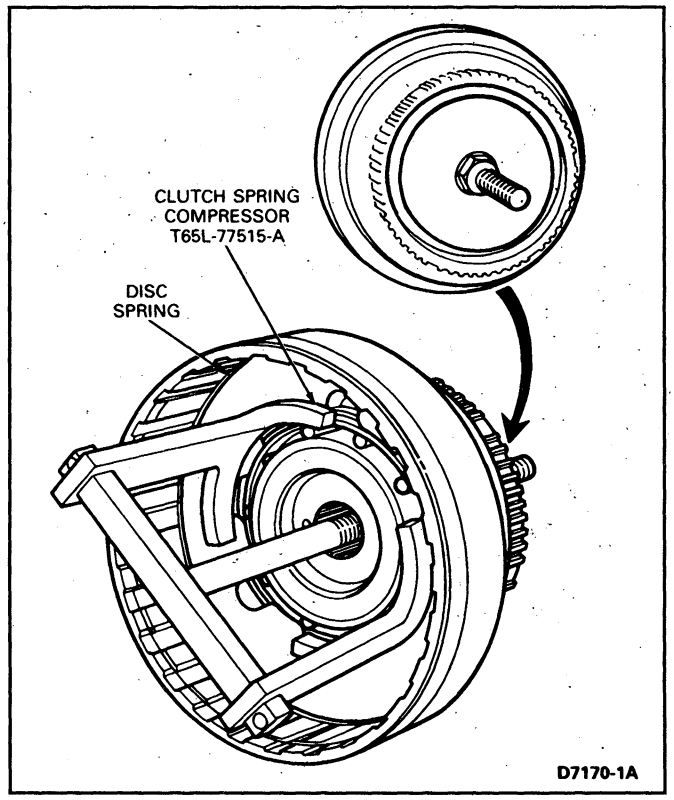


FIG. 49 Removing or Installing Disc Spring

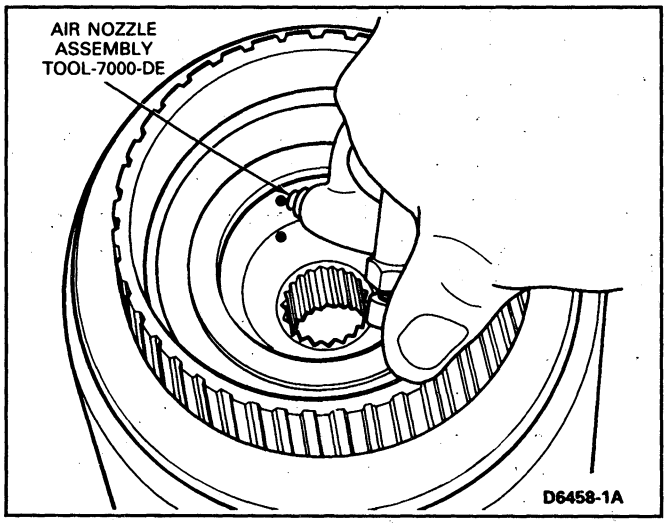


FIG. 50 Removing Forward Clutch Piston

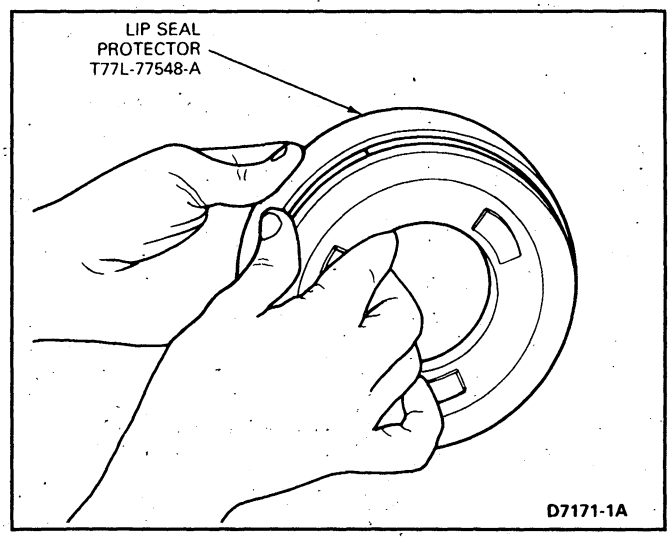


FIG. 51 Installing Forward Clutch Piston and Lip Seal

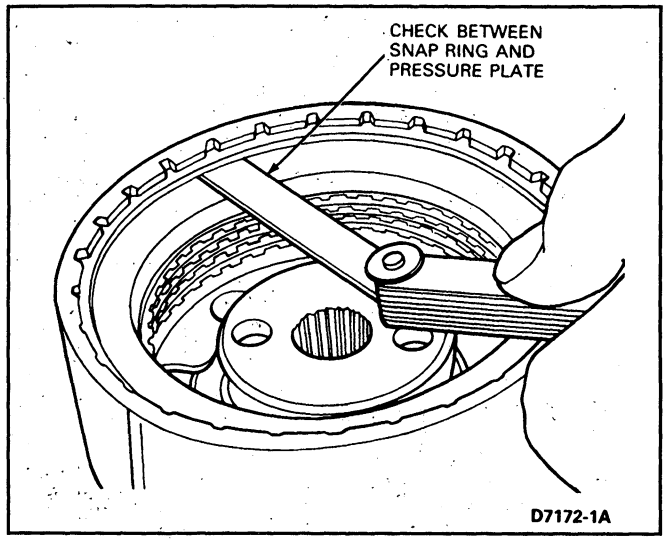


FIG. 52 Checking Forward Clutch Clearance

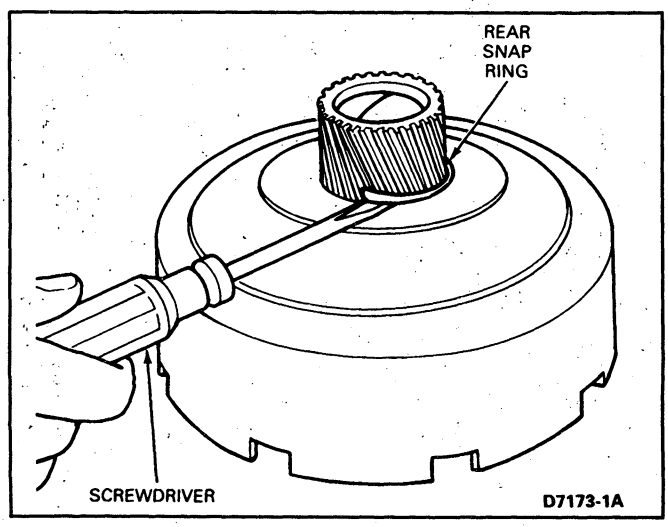


FIG. 53 Removing Sun Gear Snap Ring

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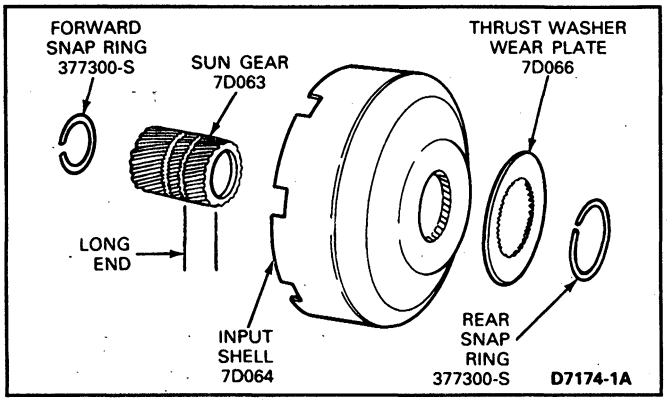


FIG. 54 Input Shell and Sun Gear Disassembled

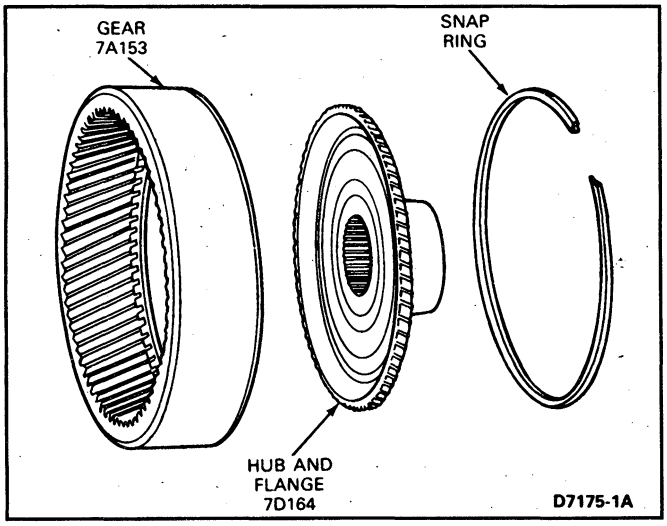


FIG. 55 Output Shaft Hub and Ring Gear

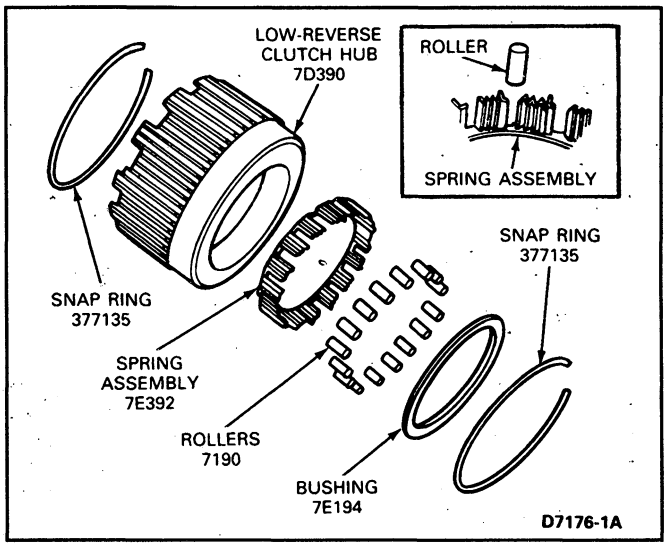


FIG. 56 One-Way Clutch Disassembled

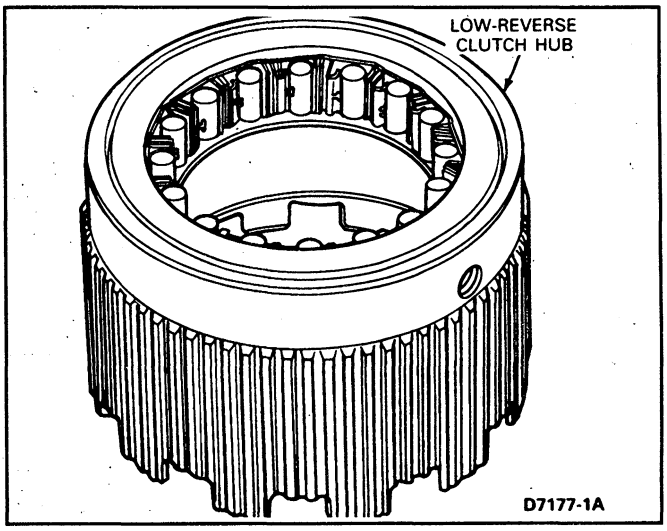


FIG. 57 One-Way Clutch Installed

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SPECIFICATIONS

C6 — TRANSMISSION REFILL CAPACITY

Vehicle	Capacity U.S. Quarts	Capacity Imperial Quarts	Capacity Liters
F-150 — F-350 (4 x 2), E-150 — E-350	11-3/4	9.4	11.2
F-150 — F-350 (4 x 4), Bronco	13-1/2	10.8	12.7

Use fluid Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (ESP-M2C166-H) or equivalent.

SELECTIVE THRUST WASHERS (FRONT PUMP SUPPORT)

Identification Color	Thickness	
	MM	Inch
Blue	1.42-1.52	0.056-0.060
Natural (White)	1.85-1.95	0.073-0.077
Red	2.23-2.33	0.088-0.092

TRANSMISSION CLUTCH PLATE USAGE

Transmission Model	Steel	Friction	Clearance	
			MM	Inch
Forward Clutch				
PGD, PJD	4①	4	0.533-1.168	0.021-0.046
High Clutch				
PGD, PJD	3	3	0.558-0.914	0.022-0.036
Reverse Clutch				
PJD	5②	5	—	—
PGD	4②	4	—	—

①Plus a waved plate (7E457) next to inner pressure plate.
②Plus a waved plate next to the piston.

CLUTCH SNAP RINGS

Part Number	Thickness		Forward	High
	MM	Inch		
377434	1.52-1.42	0.060-0.056	X	X
377126	1.75-1.62	0.069-0.064		X
377127	1.98-1.87	0.078-0.074	X	X
377128	2.20-2.10	0.087-0.083		X
377444	2.43-2.33	0.096-0.092	X	X
386841	2.89-2.79	0.114-0.110	X	
386842	3.35-3.25	0.132-0.128	X	

CHECKS AND ADJUSTMENTS

Operation	Specification
Transmission End Play	0.203-1.117 mm. (0.008-0.044 inch) (Selective Thrust Washers Available)
Torque Converter End Play	New or rebuilt 0.533 mm. (0.021 inch) max. Used 1.016 mm. (0.040 inch) max. ①
Intermediate Band Adjustment	Remove and discard locknut. Install new locknut. Adjust screw to 14 N•m (10 ft-lbs) torque, then back off 1-1/2 turns. Hold screw and tighten locknut to 54 N•m (40 ft-lbs)
Forward Clutch Pressure Plate-to-Snap Ring Clearance	0.533-1.168 mm. (0.021-0.046 inch)
VRV to Transmission Vacuum Diaphragm — 6.9L Diesel	6.9 In Hg Vacuum with gauge block in place. See adjustment procedure.

Operation	Specification
Selection Snap Ring Thickness	1.42-1.52 mm. (0.056-0.060 inch) 1.62-1.75 mm. (0.064-0.069 inch) 1.87-1.98 mm. (0.074-0.078 inch) 2.10-2.20 mm. (0.083-0.087 inch) 2.33-2.43 mm. (0.092-0.096 inch) 2.79-2.89 mm. (0.110-0.114) 3.25-3.35 mm. (0.128-0.132 inch)
Reverse-High Clutch Pressure Plate-to-Snap Ring Clearance	0.558-0.914 mm. (0.022-0.036 inch)
Selective Snap Ring Thickness	1.42-1.52 mm. (0.056-0.060 inch) 1.62-1.75 mm. (0.064-0.069 inch) 1.87-1.98 mm. (0.074-0.078 inch) 2.10-2.20 mm. (0.083-0.087 inch) 2.33-2.43 mm. (0.092-0.097 inch)

①To check end play, exert force on checking tool to compress turbine to cover thrust washer wear plate. Set indicator at zero. CD2845-2J

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TORQUE LIMITS

Item	(ft-lbs)	N-m	Item	(ft-lbs)	N-m
Converter to Flywheel	20-34	28-45	Converter Drain Plug	8-28	11-37
Front Pump to Transmission Case	16-30	22-40	Manual Valve Inner Lever to Shaft	30-40	41-54
Overrunning Clutch Race to Case	18-25	25-33	Downshift Lever to Shaft	12-16	17-21
Oil Pan to Case	8-12	11-16	Filler Tube to Engine (Econoline-5.0L/5.8L/7.5L)	40-50	54-67
Stator Support to Pump	12-16	17-21	Filler Tube to Engine (Econoline 4.9L)	33-42	44-56
Converter Cover to Converter Housing	12-16	17-21	Filler Tube to Engine (Econoline 6.9L)	24-35	32-47
Guide Plate to Case	12-16	17-21	Transmission to Engine (Diesel Only)	50-65	67-87
Intermediate Servo Cover to Case	14-20	19-27	Transmission to Engine (All Gasoline Engines)	40-50	55-67
Diaphragm Assy. to Case	12-16	17-21	Rear Engine Support to Transmission	60-80	80-107
Distributor Sleeve to Case	12-16	17-21	Plug Case — Throttle Pressure	6-12	8.5-16
Extension Assy. to Transmission Case	25-35	34-47	5/16" Fitting — Cooler Line Connector to Case — Front and Rear (Case Fitting)	18-23	25-32
Plug — Case Front Pump or Line Pressure	6-12	8.5-16			
Pressure Gauge Tap	6-12	8.5-16	5/16" Tube Nut — Cooler Line to Trans. Case Fitting	12-18	17-24
Band Adj. Screw Locknut to Case	35-45	48-61			
	(in-lb)	N-m		(in-lb)	N-m
End Plates to Body	20-45	2.5-5	Reinforcing Right Side Plate to Lower Body	20-45	2.5-5
End Plates to Body	20-40	2.5-4.5	Converter Hsg. Cover to Converter Hsg. (7.5L)	30-60	3.5-6.5
Inner Downshift Lever Stop	20-45	2.5-5	Control Assy. to Case	95-125	11-14
Reinforcement Plate to Body	20-45	2.5-5	Gov. Body to Collector Body	90-120	10.5-13.5
Screen and Lower to Upper Valve Body	40-55	5-6.2	Detent Spring to Case	80-120	9.5-13.5
Shift Valve Plate to Upper Body	20-45	2.5-5	Rear Engine Support to Frame	40-60	5-6.5
Upper to Lower Body	40-55	5-6.2	Neutral Switch to Case	55-75	6.5-8
VRV to Fuel Injector Pump	75-90	8-10.5			

CD4721-2B

CLUTCH AND BAND APPLICATION CHART

	Forward Clutch	One Way Clutch	Low Reverse Clutch	Intermediate Band	Reverse High Clutch
1st Gear — Manual Low	Applied		Applied		
1st Gear — D	Applied	Holding			
2nd Gear — D	Applied			Applied	
3rd Gear — D	Applied				Applied
Reverse (R)			Applied		Applied

CD7744-2A

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SPECIAL SERVICE TOOLS

SERVICE TOOLS

Number	Description
T50T-100-A	Impact Slide Hammer
T59L-100-B	Impact Slide Hammer
T58L-101-B	Puller Attachment
T57L-500-B	Bench Mounted Holding Fixture
TOOL-1175-AC	Seal Remover
TOOL-4201-C	Dial Indicator With Bracketry
TOOL-7000-DD	Rubber Tip For Air Nozzle
TOOL-7000-DE	Air Nozzle Assembly
T66L-7003-C2	Front Pump Bushing Replacer
T67P-7341-A	Shift Linkage Insulator Tool
T84P-7341-A	Shift Linkage Grommet Remover (In-Vehicle)
T84P-7341-B	Shift Linkage Grommet Replacer (In-Vehicle)
T61L-7657-B	Extension Housing Seal Replacer
T77L-7697-C	Extension Housing Bushing Replacer
T77L-7697-D	Extension Housing Bushing Remover
T76L-7902-C	Converter Clutch Torquing Tool
T80L-7902-A	End Play Checking Tool
T77L-7902-R	Converter Clutch Holding Tool
T73P-77060-A	Output Shaft Retainer Pliers
TOOL-77288	Shift Lever Seal Replacer
T71P-77370-A	Band Adjustment Torque Wrench Set
T65L-77515-A	Clutch Spring Compressor
T77L-77548-A	Lip Seal Protector
T87L-77837-AH	Front Pump Seal Replacer
T83T-7B200-AH	VRV Gage Block
T69L-7D044-B	Clutch Housing Bushing Tool

CD3139-1G

ROTUNDA EQUIPMENT

Model No.	Description
014-00106	Engine/Transmission Stand

CD4912-1B

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SECTION 17-20 Automatic Overdrive Transmission

SUBJECT	PAGE
ADJUSTMENTS	
Throttle Valve (TV) Control Cable Adjustment	17-20-3
TV Cable Adjustment with Engine Off	17-20-4
TV Control Pressure Check and Adjustment with Engine On	17-20-6
DESCRIPTION	17-20-1
DIAGNOSIS AND TESTING	
Shift Trouble Diagnosis	17-20-2
TV Control Cable System	17-20-2
Throttle Valve (TV) Cable System	17-20-2
DISASSEMBLY AND ASSEMBLY	
Reverse Clutch	17-20-27
2-3 Accumulator	17-20-30
Case Bushing	17-20-39
Low-Reverse Servo	17-20-30
Overdrive Servo	17-20-30
Pump and Intermediate Clutch Piston	17-20-29
Pump Bushing	17-20-39
Sun Gear and Drive Shell	17-20-29
Valve Body	17-20-30
Sub-Assemblies	17-20-22
Forward Clutch	17-20-26
Governor	17-20-22
Intermediate One-Way Clutch	17-20-22
Manual and Throttle Linkage	17-20-23

SUBJECT	PAGE
DISASSEMBLY AND ASSEMBLY (Cont'd)	
Sub-Assemblies (Cont'd)	
Output Shaft	17-20-23
Parking Pawl	17-20-22
Transmission	17-20-16
Assembly	17-20-39
Disassembly	17-20-16
REMOVAL AND INSTALLATION	
2-3 Accumulator Piston	17-20-12
Extension Housing	17-20-13
Extension Housing Bushing	17-20-13
Extension Housing Bushing and Rear Seal	17-20-13
Extension Housing Seal	17-20-13
Front Pump Seal	17-20-16
Governor	17-20-14
Internal and External Shift Linkage	17-20-14
Low-Reverse Servo Assembly	17-20-11
Main Control Valve Body	17-20-8
Neutral Start Switch	17-20-16
Transmission in Vehicle	17-20-16
Transmission Out of Vehicle	17-20-16
Overdrive Servo Assembly	17-20-10
Transmission	17-20-6
SPECIFICATIONS	17-20-47
VEHICLE APPLICATION	17-20-1

VEHICLE APPLICATION

Applies to all E-150 Through E-250, F-150 Through F-250, and Bronco Vehicles with AOD Automatic Transmission.

DESCRIPTION

Fig. 1 shows the location of the converter, front pump, clutches, gear train and most of the internal parts used in the Automatic Overdrive Transmission.

The Automatic Overdrive Transmission provides fully automatic operation in either the Ⓓ (overdrive) or D (overdrive lockout) positions. Manual upshifting and downshifting is available through the forward drive positions Ⓓ, D, 1.

NOTE: There is no 2 (second) selector position for an automatic overdrive transmission therefore second gear starts are not available.

Ⓓ (OVERDRIVE) - This is the normal driving position for an Automatic Overdrive Transmission. In this position the transmission starts in first gear and as the vehicle accelerates, automatically upshifts to second, third and fourth gear. The transmission will automatically downshift as vehicle speed decreases.

NOTE: The transmission will not shift into or remain in overdrive gear when the accelerator is pushed to the floor.

The Automatic Overdrive Transmission differs from conventional 3 speed automatic transmissions in that the planetary gear set operates in 4th gear. Some audible perception of planetary action can exist as with any other mechanical device and should be accepted as being commercially quiet unless some abnormal noise is present.

D (OVERDRIVE LOCKOUT) - In this position the transmission operates as in Ⓓ (OVERDRIVE) except that there is no overdrive (fourth) gear. This position may be used when driving up or down mountainous roads to provide better performance and greater engine braking than the overdrive position. The transmission may be shifted from Ⓓ to D or D to Ⓓ at any vehicle speed.

1 (LOW)—This position can be used when maximum engine braking is desired. To help brake the vehicle on hilly roads where D (OVERDRIVE LOCKOUT) does not provide enough braking, shift the selector lever to 1 (LOW). At vehicle speeds above approximately 20 MPH the transmission will shift to second gear, and remain in second gear. When vehicle speed drops below approximately 20 MPH the transmission will downshift to first gear, and remain in first gear. Upshifts from 1 (LOW) can be made by manually shifting to Ⓓ (OVERDRIVE) or D (OVERDRIVE LOCKOUT). When 1 (LOW) is used for starting up, the transmission starts in first gear and stays in first gear.

FORCED DOWNSHIFTS—At vehicle speeds from approximately 50 MPH to 20 MPH in Ⓓ (OVERDRIVE) or D (OVERDRIVE LOCKOUT) the transmission will downshift to second gear when the accelerator is

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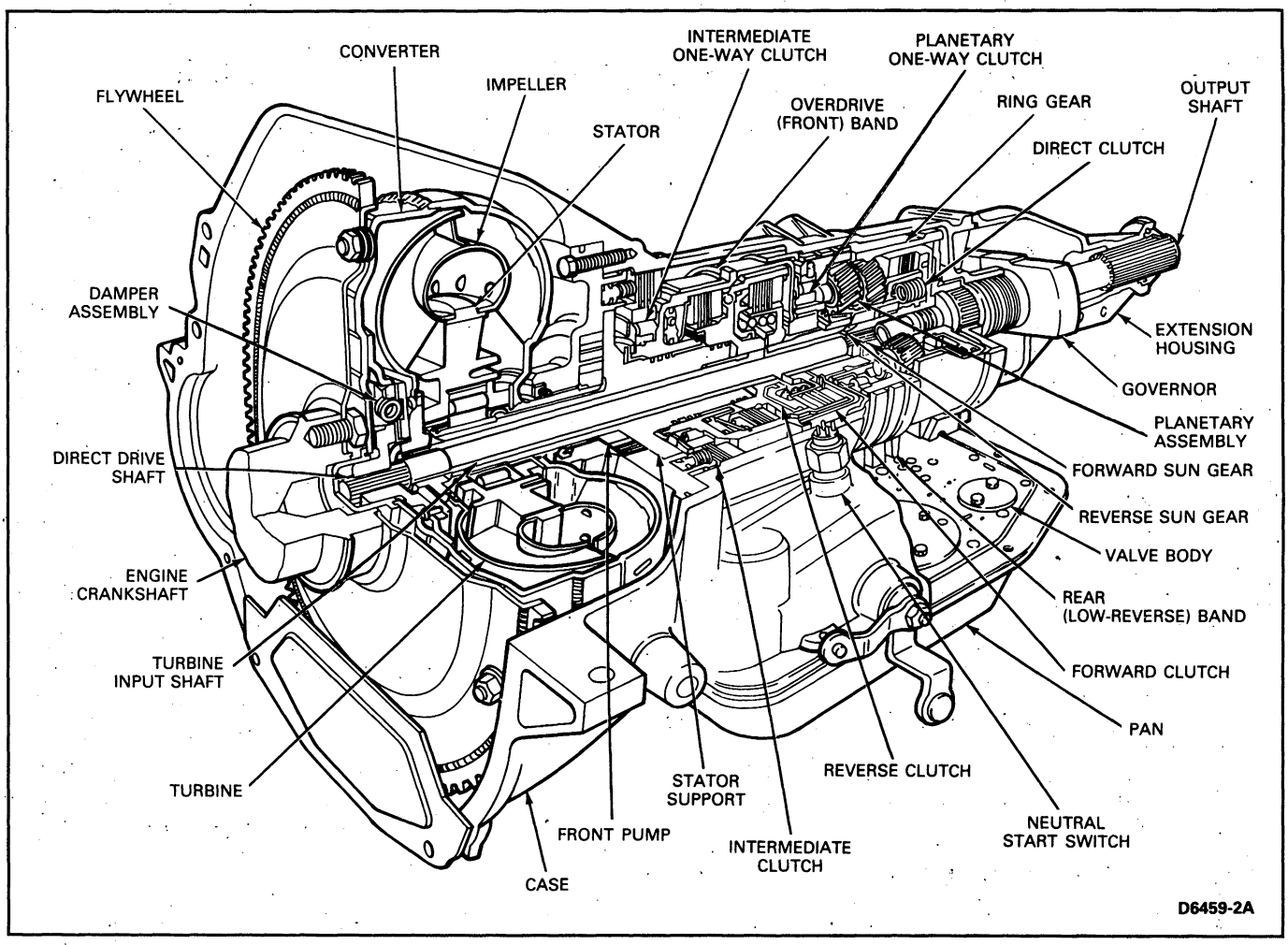


FIG. 1 Automatic Overdrive Transmission

pushed to the floor. At vehicle speeds above approximately 50 MPH the transmission will not downshift to second gear. At vehicle speeds below approximately 20 MPH the transmission will downshift to first gear when the accelerator is pushed to the floor. At most vehicle speeds in Ⓓ (OVERDRIVE) the transmission will downshift from fourth gear to third gear when the accelerator is pushed for moderate to heavy acceleration.

DIAGNOSIS AND TESTING

For diagnosis and testing procedures not listed in this Section refer to Section 17-01, General Automatic Transmission Service.

Throttle Valve (TV) Cable System

The AOD Transmission employs a TV (Throttle Valve) Control Cable System on both the 4.9L (300 CID) Electronic Fuel Injected (EFI) engine and the 5.0L (302 CID) Electronic Fuel Injected (EFI) engine (Fig. 2).

The 4.9L engine is available with the F-150 and the E-150.

The 5.0L EFI engine is available with F-150-F-250, the E-150-E-250 and Bronco.

Shift Trouble Diagnosis

TV Control Cable System

Refer to Fig. 2.

A. **Symptoms:** Excessively early and/or soft upshifts with or without slip-bump feel. Slip-bump feel on light throttle shift into and out of 4th gear (3-4 and/or 4-3 shifts). No forced downshift (kick-down) function at appropriate speeds.

Cause: TV control cable set too long.

Remedy: Reset cable per procedure for the TV control cable system.

Cause: Cable is broken or disconnected at the throttle body.

CAUTION: Do not drive vehicle if cable is broken or disconnected at throttle body.

Damage to friction elements in transmission may result due to excessive slipping since TV pressure will remain near zero. If it is necessary to drive vehicle before repairing or resetting cable, disconnect cable at the transmission lever. TV pressure will now be near maximum allowing light throttle operation. However, shifts will be delayed and harsh.

Remedy: Replace/reconnect cable and reset per procedure for the TV control cable system.

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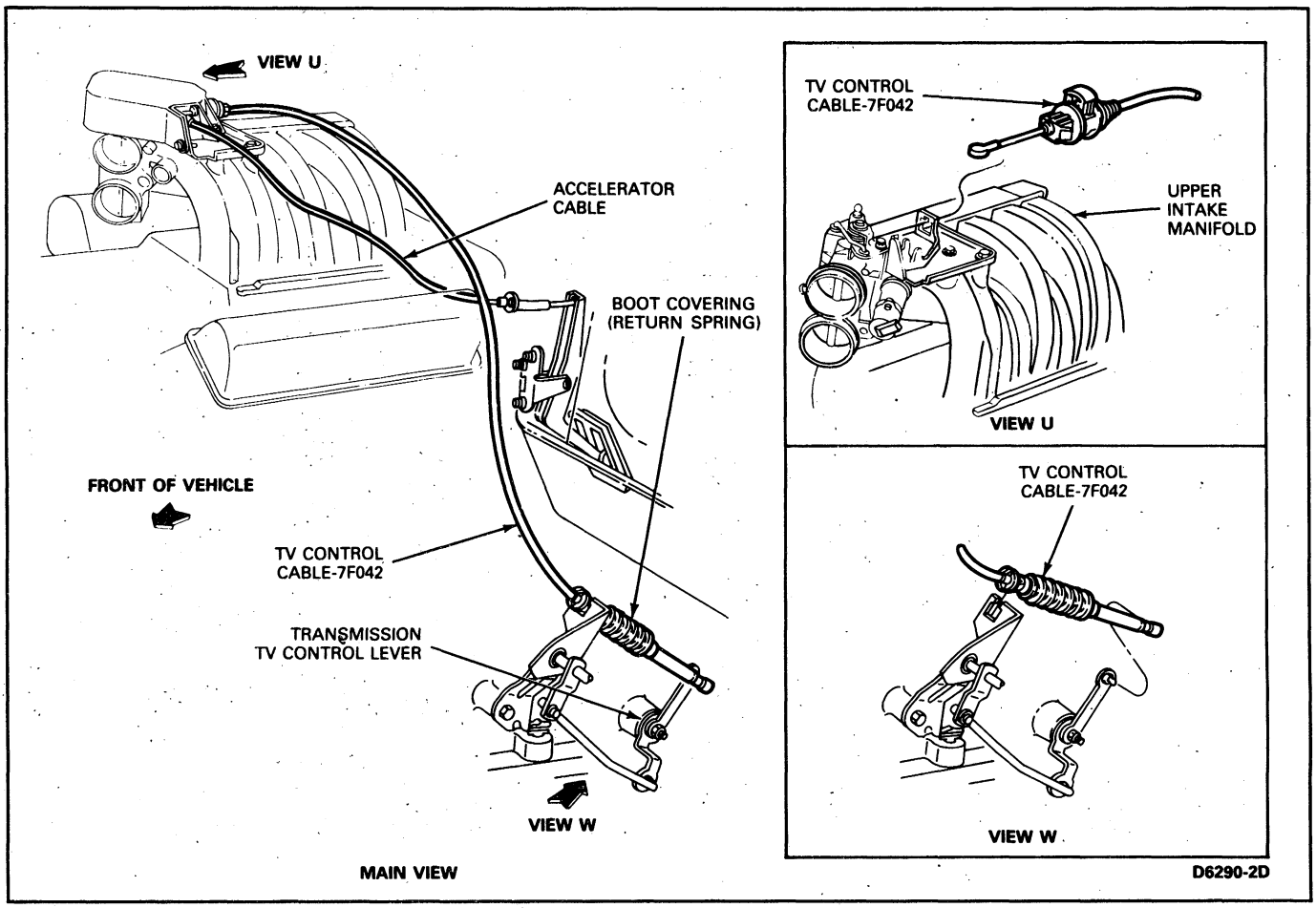


FIG. 2 Typical TV Control Cable System—5.0L (302 CID) EFI Engine Shown

B. **Symptoms:** Shift clunk when throttle is backed off after full or heavy throttle acceleration. Harsh coasting downshifts out of 4th gear (automatic 4-3 shifts in Ⓓ range).

Cause: TV control cable is set too short.

Remedy: Reset cable per procedure for the TV control cable system.

Cause: TV control cable is not locked, locking key is in up position.

Remedy: Set cable per procedure for the TV control cable system.

Cause: Transmission lever does not return to idle (lever to rear as far as possible) although cable is correctly set.

Remedy: Check for binding due to misaligned or damaged cable brackets or damaged cable or return spring (in rubber boot). Check for binding at cable connections at throttle body or transmission. Pry off cable from the TV lever ball stud and check for free movement of the cable. Lubricate the ball stud with a small amount of Long-Life Lubricant C1AZ-19590-E (ESA-M1C75-B) or equivalent lubricant or equivalent and reattach the cable. Check for frozen moisture in cable due to damaged boot. Repair or replace as necessary. Set cable per procedure for the TV control cable system.

Cause: Cable assembly not correctly attached to bracket at either throttle body or transmission.

Remedy: Determine reason for cable becoming detached. Replace if necessary. Set cable per procedure for the TV control cable system.

C. **Symptoms:** Extremely delayed and harsh upshifts, especially at light to moderate acceleration and harsh idle engagement.

Cause: Cable disconnected at transmission (transmission TV pressure is at maximum).

Remedy: Determine cause for cable becoming disconnected. Repair or replace as necessary. Set cable per procedure for the TV control cable system.

Cause: Transmission lever stays at WOT or part throttle although cable is correctly set.

Remedy: Check for binding conditions as detailed in Part B above. Repair or replace as necessary. Set cable per procedure for the TV control cable system.

ADJUSTMENTS

Throttle Valve (TV) Control Cable Adjustment

Service Adjustment Procedure

Two methods of TV system adjustment are available.

a. TV cable adjustment with engine off.

b. TV control pressure check and adjustment procedure with engine on.

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The Throttle Valve (TV) Control Cable System consists of a cable attaching stud on the throttle body throttle lever, the TV Control Cable Assembly, the External TV Control Lever on the transmission, and the Cable Mounting Brackets at the throttle body and transmission (Fig. 3). As the throttle body lever is moved from idle to wide open throttle (WOT), the TV control cable pulls the transmission TV control lever from idle to WOT. Return of the cable and transmission lever towards idle is accomplished by the return spring on the transmission end of the cable assembly. This spring and the end of the cable assembly is protected by a flexible rubber boot. The transmission external TV control lever actuates the internal TV control mechanism which regulates the TV control pressure. The travel of this lever is controlled by stops internal to the transmission.

The TV control cable is set and locked to its proper length during initial assembly by pushing in the locking tab at the carburetor end of the cable assembly. When the tab is unlocked, the cable is released for adjustment. The take-up spring at this end of the cable automatically tensions the cable when released. With the slack taken up and the locking tab pushed in, the take-up spring plays no part in the operation of the system.

Under normal circumstances, it should not be necessary to alter or readjust the initial setting of the TV control cable. Situations requiring readjustment of the TV control cable include maintenance involving the removal and/or replacement of the throttle body, transmission, or TV cable assembly.

When the TV control cable is properly set, the transmission TV control lever will be at its internal idle stop (lever to rear as far as it will travel) when the throttle body throttle lever is at its idle stop.

TV Cable Adjustment with Engine Off

Note: At WOT, the transmission TV control lever may or may not be at its WOT stop. The wide open throttle position must not be used as a reference point for adjusting the TV control cable.

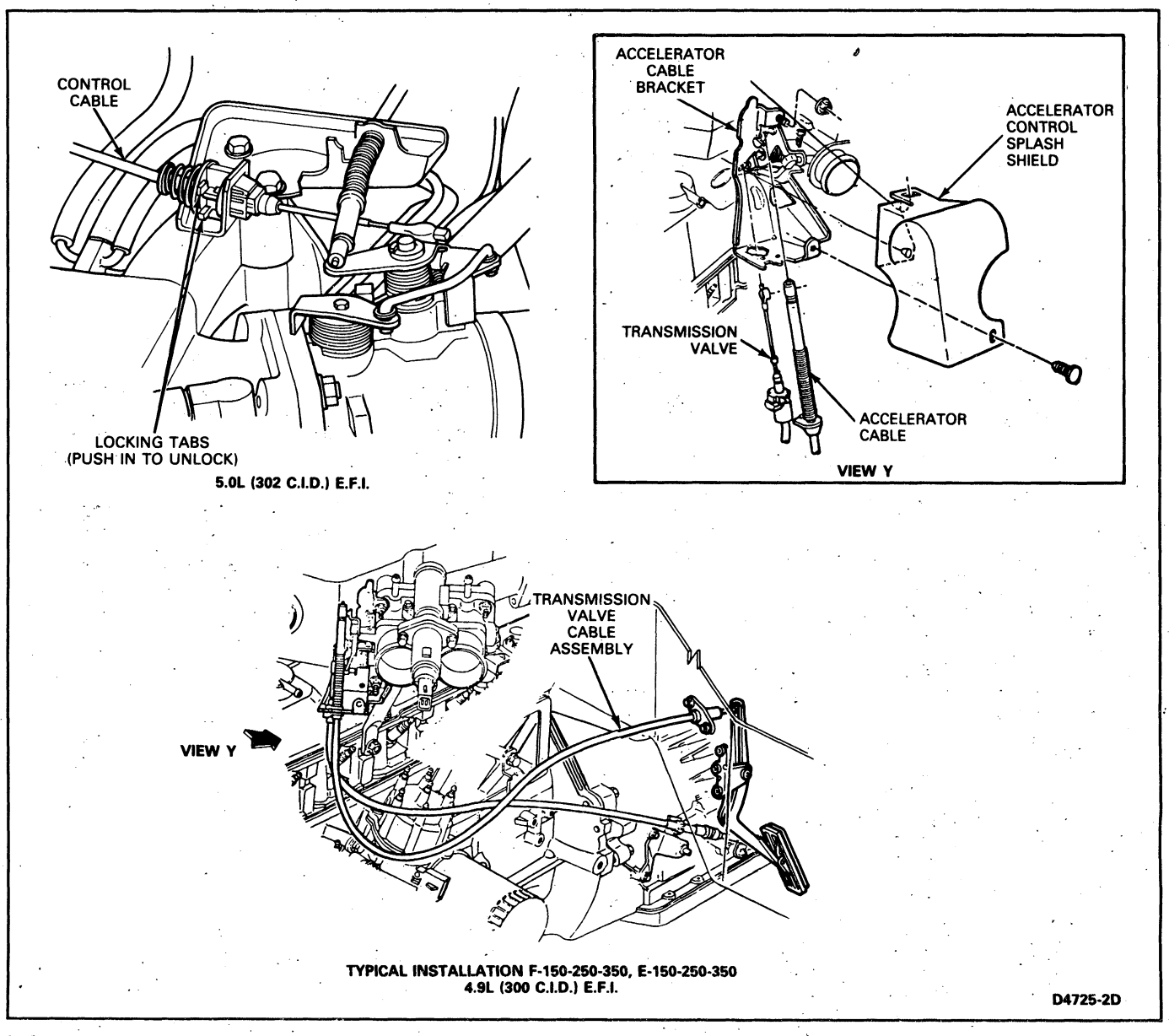


FIG. 3 Unlock Throttle Valve (TV) Control Cable Locking Tab

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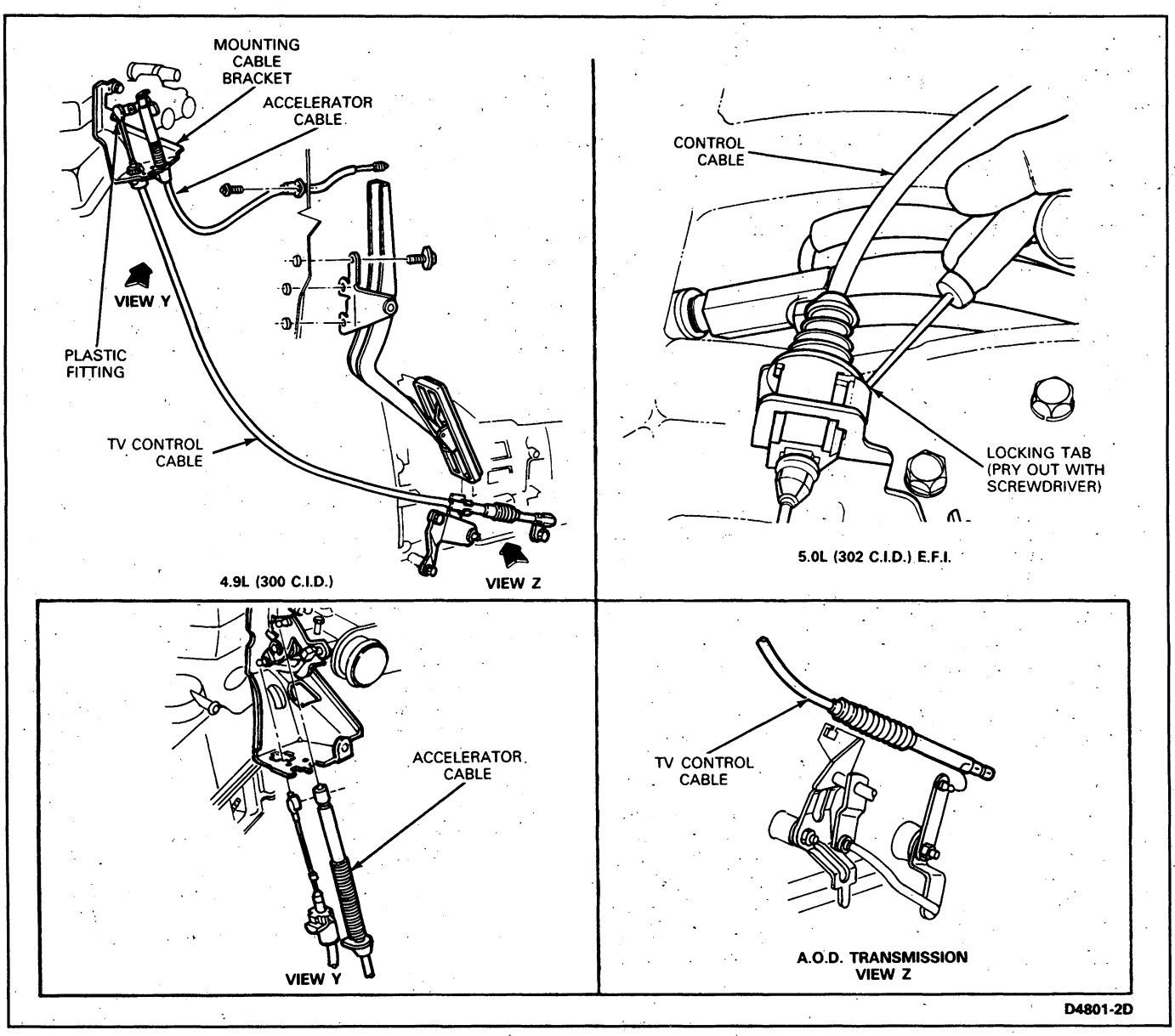


FIG. 4 Prying Up Throttle Valve (TV) Control Cable Locking Tab

Idle Speed Affect on the TV Control Cable

Both the 4.9L (300 CID) EFI and the 5.0L (302 CID) EFI Engines use an air By-Pass ISC that does not affect throttle position. Therefore, idle automatic setting does not affect TV Cable adjustment.

TV Cable Adjustment Procedure—Retention Spring—

4.9L (300 CID) EFI and 5.0L (302 CID) EFI

1. Set parking brake and put selector in "N" (Do not put selector in "P").
2. Remove the protective cover over the cable linkage on the 4.9L (300 CID) and 5.0L (302 CID) engines.
3. Verify that the throttle lever is at the idle stop. If it isn't, check for binding or interference in the throttle system. **Do Not Attempt to Adjust Idle Stop.**
4. Verify that the cable routing is free of sharp bends or pressure points and that the cable operates freely. Lubricate the TV lever ball stud with Long-Life Lubricant C1AZ-19590-E (ESA-M1C75-B) or equivalent if necessary. Check for damage to cable or rubber boot.
5. Unlock the locking tab at the throttle body end by pushing up from below, and prying up the rest of the way to free the cable (Figs. 3 and 4).
6. A retention spring must be installed on the TV control lever, to hold it in the idle position (as far to rear as the lever will travel) with about ten pounds of force. If a suitable single spring is not available, two V8 TV return springs may be used. Attach retention spring(s) to the transmission TV lever and hook rear end of spring to the transmission case (Fig. 5).
7. With the TV cable locking tab unlocked and the retention spring in place, rotate the transmission outer TV lever 10 degrees-30 degrees and return slowly.
8. Push down on the locking tab until flush (Fig. 6).

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9. Remove the retention spring(s) from the transmission TV lever.

TV Control Pressure Check and Adjustment with Engine On

NOTE: This procedure requires the use of TV Pressure Gauge with Hose, T86L-70002-A or equivalent. The results of the adjustment procedure depends on the accuracy of the pressure gauge. The pressure gauge should be checked (and recalibrated if necessary) approximately four times a year or when the following occurs:

a. The needle will not return to 0 psi under no pressure.

b. The needle goes past 0 psi (negative side) under no pressure.

c. Bumping or dropping a pressure gauge.

1. Attach TV Pressure Gauge with Hose, T86L-70002-A or equivalent to the TV port on the transmission. On some applications it might be easier to use the TV Pressure Fitting Service Tool No. D80L-77001-A.
2. Remove the protective cover over the cable linkage on the 5.0L (302 C.I.D.) EFI Engine.
3. Insert the tapered end of the Cable TV Control Pressure Gauge Tool, T86L-70332-A between the crimped slug on the end of the cable and the plastic cable fitting that attaches to the throttle lever (Fig. 7). Push in gauge tool, forcing the crimped slug away from the plastic fitting. Make sure gauge tool is pushed in as far as it will go.
4. Operate the engine until normal operating temperature is reached (Approx. 5-10 min. with transmission in park). The transmission fluid temperature should be approximately 100-150 degrees F. Do not make pressure check if transmission fluid is cold or too hot to touch.
5. Set parking brake and place shift selector in N (neutral). With gauge block in place and engine idling in neutral, the TV pressure should be 31 ± 5 psi (5.0L) and 35 ± 5 psi (4.9L). For best transmission function, set the TV pressure as close as possible to the mean pressure using the following procedure.

   NOTE: Do not check or set TV pressure in P (Park).

6. Unlock the TV Cable Locking Tab at the carburetor (or throttle body). The adjuster preload spring should cause the adjusting slider to move away from the throttle body and the TV pressure should increase.
7. Push on the slider from behind the bracket until the TV pressure is 33 psi. While still holding the slider, push down on locking tab as far as it will go, locking slider in position.
8. Remove gauge tool, allowing cable to return to its normal idle position. With the engine still idling in neutral, TV pressure must be at or near zero (less than 5 psi). If not, reinstall gauge tool. Repeat steps 6 and 7 but set the TV pressure to a pressure lower than previously set but not less than 26 psi (5.0L), 30 psi (4.9L). Remove gauge tool and recheck TV pressure to determine if it is at or near zero.

REMOVAL AND INSTALLATION

Transmission

NOTE: Completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. In addition, the cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission. Cleaning and flushing procedures for transmission components, including the direct clutch check ball, can be found in the cleaning and inspection area of Section 17-01 General Automatic Transmission Service.

NOTE: Do not soak oil filter in solvent cleaner. The filter material could disintergrate. Replace filter if transmission fluid is contaminated.

Removal

1. Disconnect the battery negative cable.
2. Raise the vehicle on a hoist or stands.
3. Place a drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold the pan in place.
4. Remove the converter drain plug access cover from the lower end of the converter housing.
5. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the nuts.
6. Place a drain pan under the converter to catch the fluid. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to

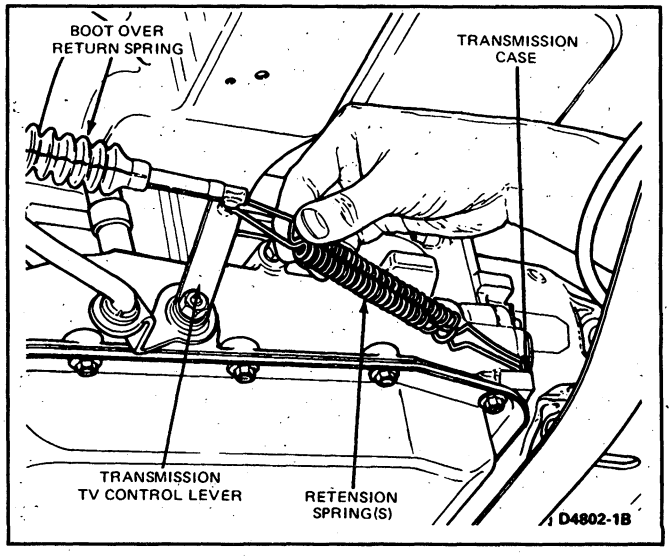


FIG. 5 Transmission TV Lever Retention Spring—4.9L (300 CID) EFI and 5.0L (302 CID) EFI

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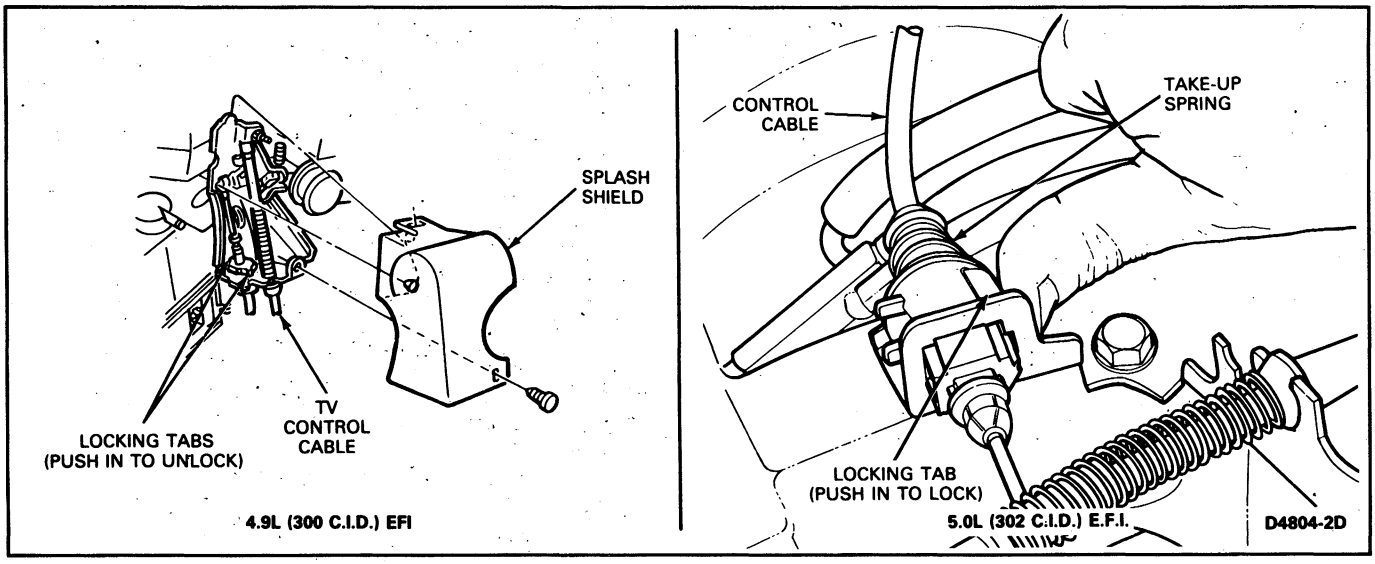


FIG. 6 Throttle Valve (TV) Control Cable Locking Tab Installation—Typical

the converter drain plug and remove the plug. After the fluid has been drained, reinstall the plug.

7. Disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission.

   NOTE: To maintain initial driveshaft balance, mark the REAR driveshaft yoke and axle companion flange so they may be installed in their original positions.

   Install a seal installation tool in the extension housing to prevent fluid leakage.

8. Disconnect the cable from the terminal on the starter motor. Remove the two attaching bolts and remove the starter motor. Disconnect the neutral start switch wires at the plug connector.
9. Remove the rear mount-to-crossmember attaching bolts and the two crossmember-to-frame attaching bolts.
10. Remove the two engine rear support-to-extension housing attaching bolts.
11. Disconnect the TV cable from the transmission TV lever. Disconnect the manual rod from the transmission manual lever at the transmission.
12. Remove the bolt securing the bellcrank bracket to the converter housing.

    On 4x4 applications, remove the transfer case. Refer to the appropriate transfer case Section in Group 16.

13. Raise the transmission with a transmission jack to provide clearance to remove the crossmember (Fig. 8). Remove the rear mount from the crossmember and remove the crossmember from the side supports.

    NOTE: The 4x4 application has a deep well oil pan. Use a transmission jack that will allow clearance for the oil pan depth and still provide support for the transmission at the oil pan rail.

14. Lower the transmission to gain access to the oil cooler lines.
15. Disconnect each oil line from the fittings on the transmission.
16. Disconnect the speedometer cable from the extension housing.
17. Remove the bolt that secures the transmission fluid filler tube to the cylinder block. Lift the filler tube and the dipstick from the transmission.
18. Secure the transmission to the jack with the chain.
19. Remove the converter housing-to-cylinder block attaching bolts.
20. Carefully move the transmission and converter assembly away from the engine and, at the same time, lower the jack to clear the underside of the vehicle.
21. Remove the converter and mount the transmission in a holding fixture.

Transmission

Installation

1. Tighten the converter drain plug to specifications.
2. Position the converter on the transmission, making sure the converter drive flats are fully engaged in the pump gear by rotating the converter.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with a chain.
4. Rotate the converter until the studs and drain plug are in alignment with the holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot. The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft.
6. Install and tighten the converter housing-to-engine attaching bolts to specification.
7. Remove the safety chain from around the transmission.
8. Install a new O-ring on the lower end of the transmission filler tube. Insert the tube in the transmission case and secure the tube to the engine with the attaching bolt.

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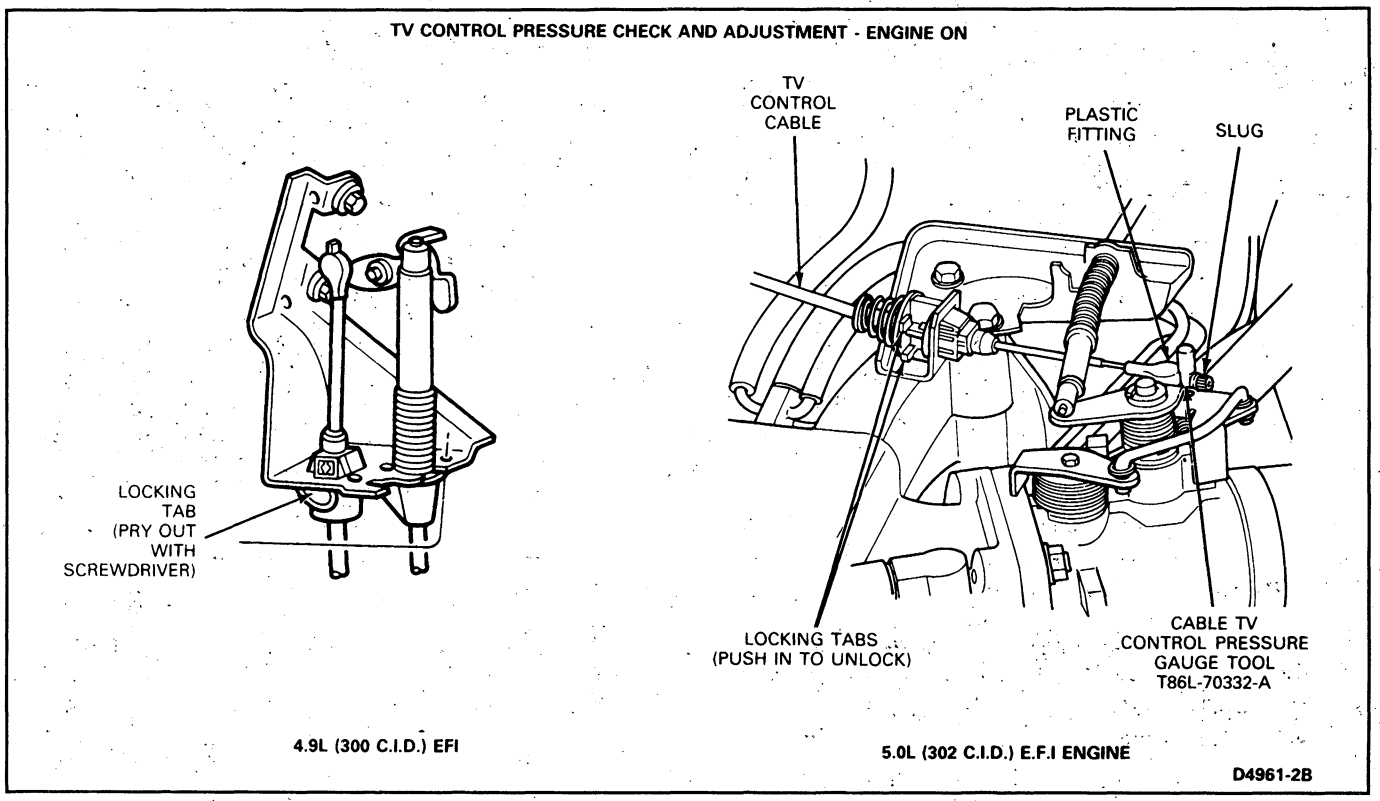


FIG. 7 TV Pressure Check and Adjustment Using Gauge Tool

9. Connect the speedometer cable to the extension housing.
10. Connect the oil cooler lines to the right side of transmission case.
11. Secure the engine rear support to the extension housing and tighten the bolts to specification.
12. Position the crossmember on the side supports. Position the rear mount on the crossmember and install the attaching bolt and nut.
13. Install the transfer case. Refer to the appropriate transfer case Section in Group 16. Lower the transmission and remove the jack.
14. Secure the crossmember to the side supports with the attaching bolts and tighten them to specification.
15. Position the bellcrank to the converter housing and install the attaching bolt.
16. Connect the TV cable to the transmission TV lever. Connect the manual linkage rod to the manual lever at the transmission.
17. Secure the converter-to-flywheel attaching nuts and tighten them to specification.
18. Install the converter housing access cover.
19. Secure the starter motor in place with the attaching bolts. Connect the cable to the terminal on the starter. Connect the neutral start switch wires at the plug connector.
20. Install the driveshaft so the index marks on the companion flange and rear yoke are aligned.
21. Adjust the shift linkage as required. Refer to Section 17-02 Shift Control Linkage.
22. Adjust throttle linkage per the procedure outlined in the beginning of this Section.
23. Lower the vehicle.
24. Fill the transmission to the correct level with the specified fluid. Refer to Section 17-01 General Automatic Transmission Service. Connect the battery negative cable. Start the engine and shift the transmission to all ranges, then recheck the fluid level.

Main Control Valve Body

Removal

1. Raise the vehicle on a hoist so the transmission oil pan is accessible.
2. Starting at the rear and working toward the front, loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.
3. Remove the transmission oil pan attaching bolts, pan and gasket. Discard gasket.
4. Remove three dacron filter to valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter (do not clean the filter).
5. Remove the detent spring attaching bolt and spring.
6. Remove the valve body to case attaching bolts (25). Remove the valve body. Discard valve body to case gasket.

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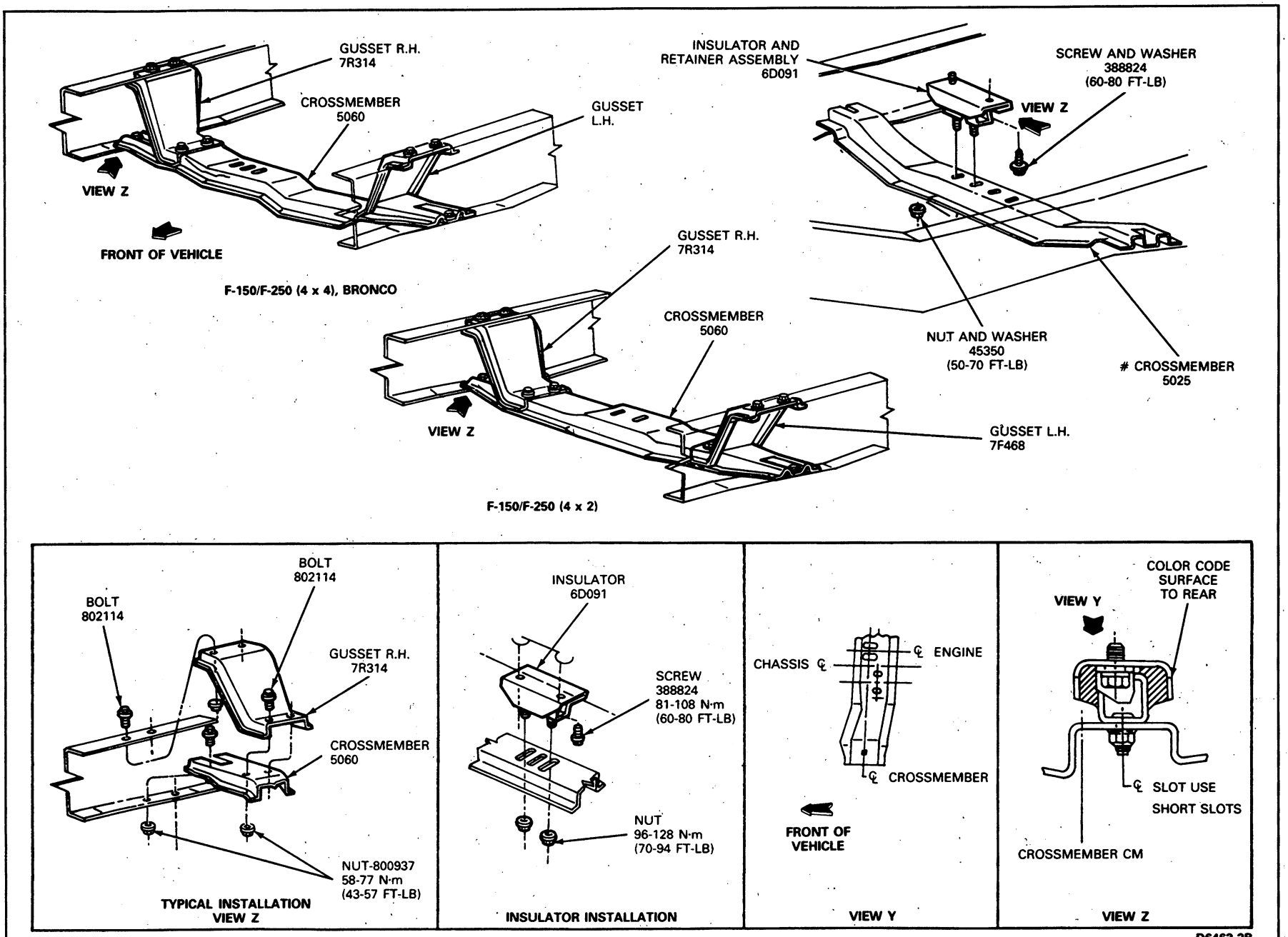


FIG. 8 Crossmember Installation E-150—E-350, F-150—F-250 (4x2/4x4) and Bronco

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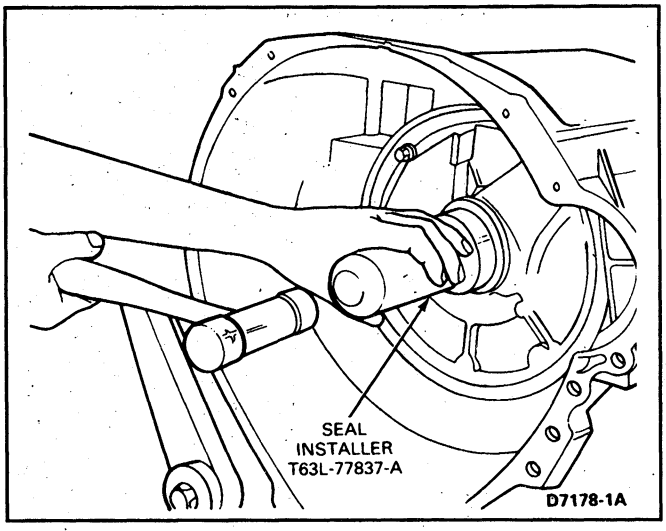


FIG. 9 Front Pump Seal Installation

Installation

1. Clean and inspect the valve body, as described in Section 17-01 General Automatic Transmission Service, prior to installation.
2. Using valve body guide pins, Tool T80L-77100-A or equivalent, position the valve body and a new gasket to the case, making sure that the inner manual lever and inner TV levers are engaged.
3. Install and tighten (25) valve body-to-case attaching bolts.
4. Install and tighten the detent spring and attaching bolts to specification.
5. Remove the guide pins and install and tighten the remaining two attaching bolts.
6. Load the throttle lever spring against the separator plate.
7. Using three dacron filter attaching bolts install the dacron filter and gasket to the valve body and tighten the attaching bolts to 9-14 N·m (80-120 in-lbs).
8. Clean the transmission oil pan and gasket surfaces thoroughly.
9. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).

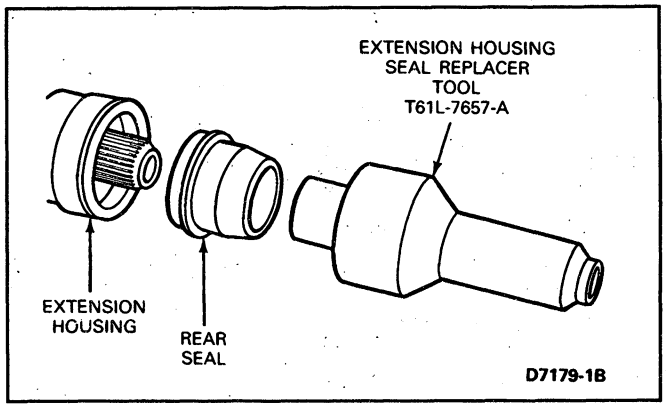


FIG. 11 Installing Extension Housing Seal

10. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01 General Automatic Transmission Service.
11. Adjust TV cable linkage as outlined in this Section.

Overdrive Servo Assembly

Refer to Fig. 15.

Removal

1. Raise the vehicle on a hoist so the transmission fluid pan is accessible.
2. Starting at the rear and working toward the front, loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.
3. Remove the transmission fluid pan attaching bolts, pan and gasket. Discard gasket.
4. Remove three dacron filter to valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter. (Do not clean the filter).
5. Remove the detent spring and attaching bolt.
6. Remove the valve body to case attaching bolts (25). Remove the valve body. Discard valve body to case gasket.

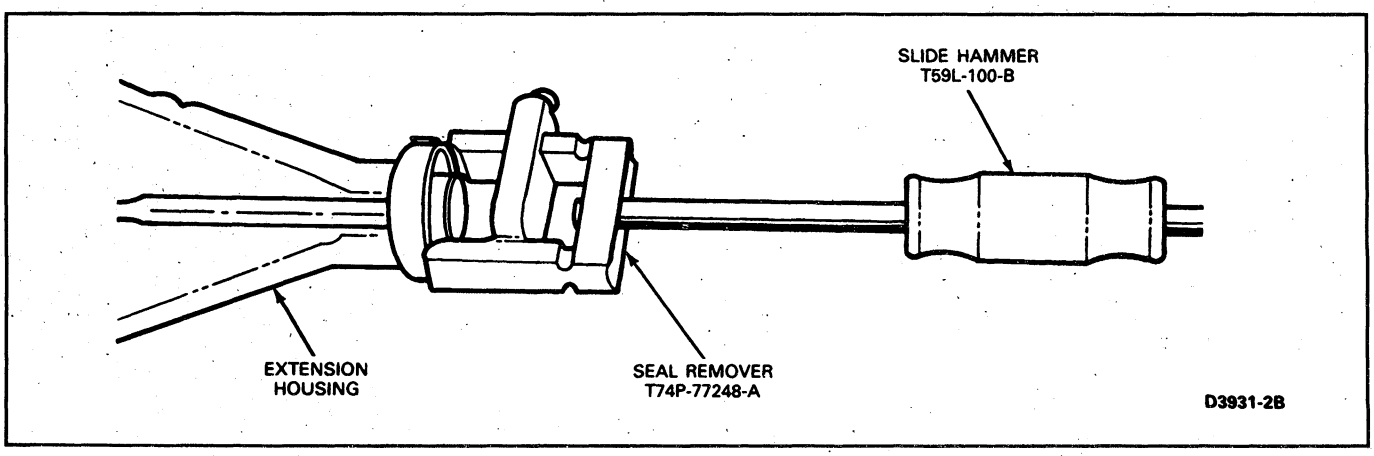


FIG. 10 Removing Extension Housing Seal

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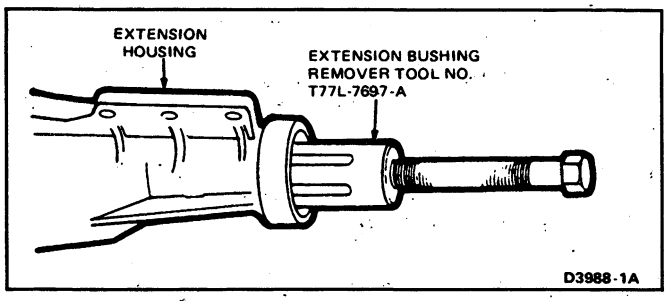


FIG. 12 Removing Extension Housing Bushing

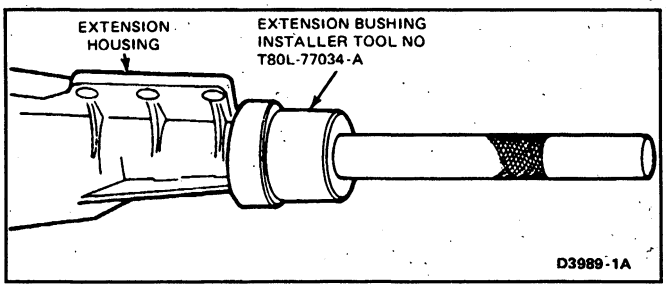


FIG. 13 Installing Extension Housing Bushing

7. Depress overdrive servo piston cover with a hammer handle and remove the retaining snap ring.
8. Using Tool T80L-77030-B or equivalent, apply air pressure to the servo piston release passage in order to remove the overdrive servo piston cover and spring. Remove the piston from the cover.
9. Remove the rubber seals from the piston and the cover.

Installation

1. Clean and inspect the servo piston and cover for nicks and/or burrs. Clean and inspect the servo piston pocket in the case for nicks and burrs also.
2. Install new servo piston and cover seals on the piston and cover, respectively.
3. Lubricate the piston seals with either clean transmission fluid or a petroleum jelly.
4. Install the servo piston into the cover, lubricate the cover seals and the overdrive servo pocket in the case.
5. Assemble the return spring to the servo piston.
6. Install the overdrive piston, cover and spring into the overdrive servo pocket in the case. Make sure the servo rod contacts the band apply pocket while installing. Failure to do so will result in a no 3-4 shift condition.
7. Using the handle of a hammer, depress the overdrive servo sufficiently to gain clear access to the retaining snap ring groove in the case. Install the snap ring.
8. Inspect the outer edge of the overdrive servo pocket for possible nicks and burrs which might have been raised during the removal or installation of the retaining snap ring.
9. Remove nicks and burrs with a "fine honing stone" and clean the expected areas thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case, and subsequent cross leakage.

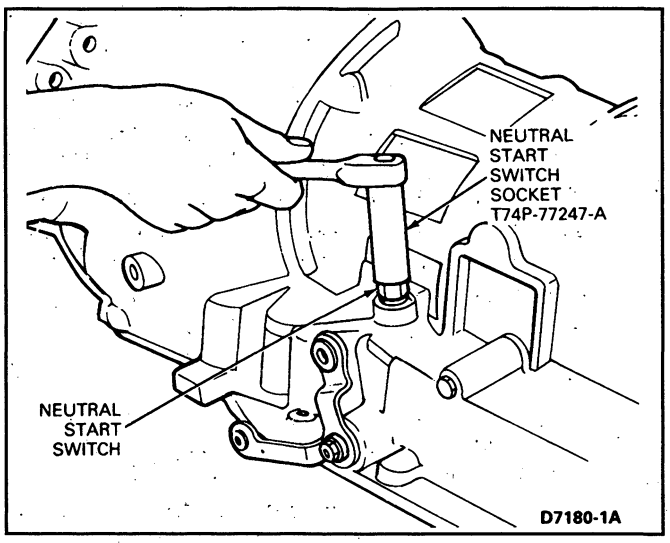


FIG. 14 Removing or Installing Neutral Start Switch

10. Clean and inspect the valve body, as described in Section 17-01 General Automatic Transmission Service, prior to installation.
11. Position a new valve body gasket to the separator plate.
12. Install valve body guide Pins, T80L-77100-A or equivalent. Position a new separator plate gasket to the valve body and case, making sure that the inner manual lever and inner TV lever are engaged.
13. Install and tighten the attaching bolts (25) to 9-14 N·m (80-120 in-lbs).
14. Install the detent spring and attaching bolt.
15. Remove the guide Pins T80L-77100-A or equivalent and install and tighten the remaining two valve body-to-case bolts.
16. Position the throttle lever spring against the separator plate.
17. Using three dacron filter attaching bolts, install the dacron filter and gasket to the valve body and tighten attaching bolts to 9-14 N·m (80-120 in-lbs).
18. Clean the transmission oil pan and gasket surfaces thoroughly.
19. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
20. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01 General Automatic Transmission Service.
21. Adjust TV cable linkage as outlined in this Section.

Low-Reverse Servo Assembly

Refer to Fig. 20.

Removal

1. Raise the vehicle on a hoist so the transmission oil pan is accessible.
2. Starting at the rear and working toward the front, loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.

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3. Remove the transmission oil pan attaching bolts, pan and gasket. Discard gasket.
4. Remove three dacron filter to valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter (do not clean the filter).
5. Remove the detent spring and attaching bolts.
6. Remove the valve body to case attaching bolts (25). Remove the valve body. Discard valve body to case gasket.
7. Depress the reverse servo piston cover with a hammer handle. Remove the retaining snap ring and piston cover.

   NOTE: Reverse servo piston may spring free from case when cover is removed. Care must be taken to prevent such an occurrence.
8. To remove the reverse servo piston and spring, apply air pressure to the servo piston release passage using Tool T80L-77030-B or equivalent. Cover the servo piston pocket to prevent the piston from falling out of the case when air is applied and becoming damaged.

Installation

1. Clean and inspect the servo pocket in the case.
2. Clean the reverse servo piston, cover and return spring. Inspect the piston and cover sealing edges for cuts, burrs or irregular wear pattern. Replace if necessary.
3. Assemble the return spring to the servo piston.
4. Install the reverse servo piston and spring and the servo cover into the case reverse servo pocket.

   NOTE: Make sure that the servo piston is reinstalled with the same rod length as the one which was removed.
5. Using the handle of a hammer, depress the reverse servo piston and cover sufficiently to gain clear access to the retaining snap ring groove in the case. Install the snap ring.
6. Inspect the outer edge of reverse servo pocket for nicks or burrs which might have been raised during the removal or installation of the retaining snap ring.
7. Remove nicks or burrs with a "fine" honing stone and clean the effected surfaces thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case and subsequent cross leakage.
8. Clean and inspect the valve body, as described in Section 17-01 General Automatic Transmission Service.
9. Position a new valve body gasket to the separator plate.
10. Install valve body guide Pins, Tool T80L-77100-A or equivalent to the case. Position a new separator plate gasket to the valve body and case, making sure that the inner manual lever and inner TV lever are engaged.
11. Install and tighten (25) attaching bolts to 9-11 N·m (80-100 in-lbs).
12. Install and tighten the detent spring and attaching bolt to 9-14 N·m (80-120 in-lbs).
13. Position the throttle lever spring against the separator plate.
14. Remove the guide Pins T80L-77100-A and install and tighten the remaining two valve body attaching bolts.
15. Using three dacron filter attaching bolts install the dacron filter and gasket to the valve body and tighten the attaching bolts to 9-14 N·m (80-120 in-lbs).
16. Clean the transmission oil pan and gasket surfaces thoroughly.
17. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
18. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01 General Automatic Transmission Service.
19. Adjust TV cable linkage as outlined in this Section.

2-3 Accumulator Piston

Refer to Fig. 15.

Removal

1. Raise the vehicle on a hoist so the transmission oil pan is accessible.
2. Starting at the rear and working toward the front loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.
3. Remove the transmission oil pan attaching bolts, pan and gasket. Discard gasket.
4. Remove the three dacron filter-to-valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter (do not clean the filter).
5. Remove the detent spring and attaching bolt.
6. Remove the valve body-to-case attaching bolts (25). Remove the valve body. Discard the valve body-to-case gasket.
7. Depress the 2-3 accumulator piston cover. Remove the retaining snap ring, cover and spring.
8. Remove the 2-3 accumulator piston.
9. Remove the seals from the 2-3 accumulator piston. If the seals have nicks, cuts or irregular wear patterns, then discard the seals.

Installation

1. Clean and inspect the 2-3 accumulator piston. Replace piston if damaged.
2. Clean and inspect the 2-3 accumulator pocket in the case for nicks, burrs or porosity.
3. Install new seals on the 2-3 accumulator piston.
4. Install the 2-3 accumulator piston into the case.
5. Install the return spring and cover.
6. Install the retaining snap ring.
7. Inspect the outer edge of 2-3 accumulator piston pocket for nicks or burrs which might have been

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raised during the removal or installation of the retaining snap ring.

8. Remove nicks or burrs with a "fine" honing stone and clean the affected surfaces thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case and subsequent cross leakage.
9. Clean and inspect the valve body, as described in Section 17-01 General Automatic Transmission Service.
10. Position a new valve body to case gasket to the separator plate.
11. Using valve body guide pins, Tool T80L-77100-A or equivalent, position the valve body to the case making sure that the inner manual lever and inner TV lever are engaged. Install and tighten (22) valve body-to-case attaching bolts to 9-11 N·m (80-100 in-lbs).
12. Install and tighten the detent spring and attaching bolt to 9-14 N·m (80-120 in-lbs).
13. Remove the guide Pins T80L-77100-A or equivalent and install and tighten the two remaining valve body attaching bolts.
14. Position the throttle lever spring against the separator plate.
15. Using three dacron filter attaching bolts install the dacron filter and gasket to the valve body and tighten the attaching bolts to 9-14 N·m (80-120 in-lbs).
16. Clean the transmission oil pan and gasket surfaces thoroughly.
17. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
18. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01.
19. Adjust TV cable as outlined in this Section.

Extension Housing Bushing and Rear Seal

Refer to Figs. 12 and 13.

Removal

1. Raise the vehicle and disconnect the driveshaft at the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original positions.
2. When only the rear seal needs replacing, carefully remove with Tool T74P-77248-A or equivalent as shown in Fig. 10.
3. Remove the bushing as shown (Fig. 12). Use the bushing remover Tool T77L-7697-A or equivalent carefully so that the output shaft spline is not damaged.

Installation

1. When installing a new bushing use special Tool T80L-77034-A or equivalent (Fig. 13).
2. Before installing a new seal, inspect the sealing surface of the universal joint yoke for scores. If scores are found, replace the yoke.
3. Inspect the counterbore of the housing for burrs. Remove burrs with crocus cloth.
4. Install the seal into the housing with Tool T61L-7657-A or equivalent (Fig. 11). The seal should be firmly seated in the bore. Coat the inside diameter of the rubber portion of the seal with Long-Life Lubricant C1AZ-19590-E (ESA-M1C75-B) or equivalent or equivalent lubricant.

Extension Housing Seal

Removal and Installation

1. Remove the driveshaft as described in Section 15-61, Driveshaft Single Type U-joint.
2. Remove the extension housing seal using Slide Hammer T59L-100-B and Seal Remover T74P-77248-A or equivalents (Fig. 10).
3. Install the extension housing seal using seal installer T61L-7657-A or equivalent (Fig. 11).
4. Connect the driveshaft as described in Section 15-61, Driveshaft-Single Type U-joint.

Extension Housing Bushing

Disassembly

1. Remove the extension housing seal using Slide Hammer T59L-100-B and Seal Remover T74P-77248-A or equivalent (Fig. 10).
2. Remove the extension housing bushing using Bushing Remover T77L-7697-A or equivalent (Fig. 12).

Installation

1. Install the extension housing bushing using Bushing Installer T80L-70034-A or equivalent (Fig. 13).
2. Install the extension housing seal using Seal Installer T61L-7657-A or equivalent (Fig. 11).

Extension Housing

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the parking brake cable from the equalizer, if so equipped.
3. Disconnect the driveshaft from the rear axle flange and remove from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original positions.
4. Disconnect the speedometer cable from the extension housing.
5. Remove the engine rear support-to-extension housing attaching bolts.
6. Place a jack under the transmission and raise just enough to remove the weight from the engine rear support.
7. Remove the bolt that secures the engine rear support to the crossmember and remove the support.
8. Place a drain pan under the rear of the transmission case.
9. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.

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NOTE: The extension housing bolts have been coated with a sealant. More break torque may be required to remove these bolts.

10. Remove and discard extension housing gasket.

Installation

1. Clean the mounting surface on the transmission and on the extension housing. Remove any sealant from the bolts and the case bolt holes. Position a new gasket on the transmission. Coat the bolts with Ford Threadlock and Sealer EOAZ-19554-AA (ESE-M4G204-A, Type II) or Ford Pipe Sealant with Teflon®, D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) Teflon® Tape or equivalent.
2. Hold the extension housing in place and secure with the attaching bolts. Tighten to specified torque.
3. Raise the transmission high enough to position the engine rear support on the crossmember.
4. Secure the support to the crossmember with the attaching bolt and nut. Tighten the bolt to 68-94 N·m (50-70 ft-lbs).
5. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolts. Tighten the bolts to 82-108 N·m (60-80 ft-lbs).
6. Secure the speedometer cable to the extension housing with the attaching bolt.
7. Connect the parking brake cable to the equalizer.
8. Install the driveshaft, aligning the index marks, in the transmission and connect shaft to rear axle flange.
9. Lower the vehicle. Fill the transmission to the correct level with the specified fluid. Refer to Section 17-01 General Automatic Transmission Service. Start the engine and shift the transmission through all ranges, then recheck the fluid level.

Governor

Refer to Fig. 25.

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the parking brake cable from the equalizer.
3. Disconnect the driveshaft from the rear axle flange and remove from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original position.
4. Disconnect the speedometer cable from the extension housing.
5. Remove the engine rear support-to-extension housing attaching bolts.
6. Place a jack under the transmission and raise just enough to remove the weight from the engine rear support.
7. Remove the bolt that secures the engine rear support to the crossmember and remove the support.
8. Place a drain pan under the rear of the transmission case.
9. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.
10. Remove and discard the extension housing gasket.

NOTE: If the governor body only is to be removed, skip Steps 11 and 12.

11. Remove the governor-to-output shaft retaining snap ring.
12. Using a soft-faced hammer, tap the governor assembly off the output shaft. Remove the governor driveball.
13. Remove the governor-to-counterweight attaching screws. Lift the governor from the counterweight.

Installation

1. Lubricate the governor valve parts with clean transmission fluid. Make certain that the valve moves freely in the valve body bore.
2. Position the governor valve body on the counterweight with the cover facing toward the front of the vehicle. Install the two attaching screws, and tighten to 6-7 N·m (50-60 in-lbs).
3. Position the governor drive ball into the pocket of the output shaft.
4. Align the key way in the counterweight to the governor drive ball. Drive the governor assembly onto the output shaft with soft-faced hammer if necessary.
5. Reinstall the governor to output shaft retaining snap ring. Clean the mounting surface on the transmission and on the extension housing. Position a new gasket on the transmission.
6. Raise the transmission high enough to position the engine rear support on the crossmember.
7. Secure the support to the crossmember with the attaching bolt and nut. Tighten the bolt to 68-94 N·m (50-70 ft-lbs).
8. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolt. Tighten the bolts to 82-108 N·m (60-80 ft-lbs).
9. Secure the speedometer cable to the extension housing with the attaching bolt.
10. Connect the parking brake cable to the equalizer. Adjust the parking brake as required.
11. Install the driveshaft, after aligning the index marks, in the transmission and connect shaft to rear axle flange.
12. Fill the transmission to the correct level with the specified fluid. Refer to Section 17-01 General Automatic Transmission Service.

Internal and External Shift Linkage

Refer to Fig. 31.

Removal

1. Raise the vehicle on a hoist so that the transmission oil pan is accessible.
2. Apply penetrating oil to the outer throttle lever attaching nut to prevent breaking the inner throttle lever.

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3. Grasp the outer throttle lever and hold firmly (Fig. 32). Then remove the outer throttle lever attaching nut and lockwasher. Swing lever and TV rod assembly or cable assembly clear for access path.
4. Carefully disconnect the shift rod at the transmission manual lever using special service Tool T67P-7341-A, T84P-7341-A or equivalent. Refer to Section 17-02 Shift Control Linkage.
5. Place a drain pan under the transmission oil pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Remove all of the attaching bolts except two at the rear to allow the fluid to further drain. It is necessary to use a 1/4 inch drive with a 10mm universal socket for access to remove the oil pan bolts. After all the fluid has drained, remove the two remaining bolts and the fluid pan. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if it is in good condition.
6. Remove transmission oil filter and gasket.
7. Remove the manual lever detent spring and roller assembly.
8. Remove manual lever retaining pin using a narrow sharp screwdriver—this must be done carefully.
9. Note assembled position of the TV lever torsion spring, then remove the spring.
10. Slide a 5/8 inch box end wrench over the inner manual lever close to the bottom of the lever. Do not allow the wrench to contact the rooster comb area. Using a 21mm wrench (some 13/16 inch wrenches secure the nut better), remove the manual lever attaching nut. Securely hold the inner manual lever with the box end wrench while applying break torque to the manual lever attaching nut.

    NOTE: Note the orientation of the outer manual lever (pointing up or down) before removal.
11. Remove the outer manual lever from the case (Fig. 32).
12. Remove the inner throttle lever and shaft assembly.
13. Remove the inner manual lever and park pawl actuating rod assembly.
14. Disconnect the park pawl actuating rod from the inner manual lever.
15. Remove the manual lever oil seal with a screwdriver, or seal remover Tool T58L-101-B or equivalent (Fig. 33). Discard the oil seal.

Installation

1. Install a new manual lever seal into the case using seal replacer Tool T74P-77498-A or equivalent (Fig. 34).
2. Check the manual lever, the shaft and the threads for damage.
3. With the manual lever attaching nut on the inner throttle lever and shaft assembly, slide the inner throttle lever through the inner manual lever.
4. Slide the outer manual lever in the case. Make sure the lever is oriented in the proper position (either up or down depending on vehicle application).
5. Allow the inner throttle lever and shaft assembly to slide through the ID bore of the outer manual lever.
6. Snug the manual lever attaching nut against the inner manual lever making sure the flats are properly aligned. Tighten the nut to remove free play, and torque the nut to specification with a crows foot or box type adapter to a torque wrench. The torque can be approximated by tightening the nut to remove free play, then turning the nut an additional 30 degrees. This is equivalent to rotating one point of the nut 1/4 inch.
7. Position TV lever torsion spring on the inner throttle valve shaft and align in notch.
8. Push manual lever all the way into the case. Make sure inner manual lever pin is engaged in manual valve detent slot and inner throttle lever is acting on the TV valve. Neutral start switch plunger must also be riding on cam surface of inner manual lever.
9. Install new manual lever retaining pin in case (light press fit). Pin must be flush to slightly below pan gasket surface.
10. Install the new throttle lever seal in the outer manual lever counterbore with a 13mm thin wall socket, using the end that the ratchet drive would be inserted into, to seat the seal. Install .030 inch to .060 inch below the surface.

    NOTE: Identification numbers on the seal must face outward.
11. Install detent spring. Make sure detent spring roller is centered on rooster comb. Tighten to 9-14 N·m (80-120 in-lbs).
12. Install the throttle valve outer lever (do not push inner throttle valve lever past throttle valve).
13. Install throttle lever lockwasher and attaching nut. Tighten nut to 16-22 N·m (12-16 ft-lbs).
14. Check park function and operation of TV lever and manual lever before further assembly.
15. Connect the shift linkage rod to the manual lever using special service Tool T67P-7341-A, T84P-7341-B or equivalent. Make sure the manual lever is in the same position as adjustment is necessary. Refer to Section 17-02 Shift Control Linkage.
16. Install a new oil filter gasket and oil filter. Tighten to 9-14 N·m (80-120 in-lbs).
17. Clean the transmission oil pan and gasket surfaces thoroughly.
18. Reassemble oil pan with a new pan gasket. Tighten bolts to 8.0-13.5 N·m (6-10 ft-lbs). It is necessary to use a 1/4 inch drive with a 10mm universal socket to reinstall the oil pan bolts.
19. Lower vehicle and add three quarts of oil.
20. Check and adjust the TV cable linkage at the throttle body.
21. Start vehicle in park, and with foot on brake, cycle gear selector several times. Recheck fluid level using the procedure in Section 17-01 General Automatic Transmission Service and add as required. Check for leaks.

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Front Pump Seal

Removal and Installation

1. Remove the transmission from the vehicle as described in this Section.
2. Remove the pump seal using seal remover TOOL-1175-AC (or equivalent) and slide hammer T59L-100-B (or equivalent).
3. Install the seal using seal installer Tool T63L-77837-A (or equivalent) (Fig. 9).
4. Install the transmission as described in this Section.

Neutral Start Switch

Transmission Out of Vehicle

Removal And Installation

1. Using the neutral start switch socket, Tool T74P-77247-A (Fig. 14) (or equivalent) remove the switch from the case.
2. Remove the O-ring seal and discard.
3. Install a new seal on the neutral start switch.
4. Install the switch in the case using the neutral start switch socket Tool T74P-77247-A (Fig. 14) (or equivalent). Tighten to 11-15 N·m (8-11 ft-lbs).

Transmission in Vehicle

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the neutral start switch electrical harness from the neutral switch. Lift the harness straight up off the switch. **(No lateral movement.)**
3. Using the neutral switch socket Tool T74P-77247-A, remove the neutral start switch and O-ring seal. (Fig. 14).

Installation

1. Install a new O-ring seal on a new neutral start switch.
2. Install the new switch and seal into the case, using the neutral start switch socket Tool T74P-77247-A (Fig. 14). Tighten to 11-15 N·m (8-11 ft-lbs).
3. Connect the neutral switch harness to the new neutral start switch.
4. Lower the vehicle.

DISASSEMBLY AND ASSEMBLY

NOTE: Before beginning the transmission overhaul review the following guidelines. These general rules are provided to emphasize the need for attention to detail and care when servicing an automatic transmission.

1. It is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service.

   In addition, the cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission.

   Cleaning and flushing procedures for transmission components, including the direct clutch check ball, can be found in the cleaning and inspection part of Section 17-01 General Automatic Transmission Service.
2. Thorough cleaning of the transmission exterior will reduce the possibility that damaging contaminants might enter the subassemblies during disassembly and assembly.
3. All fasteners must be tightened to the torque indicated in the specifications at the end of this Section.
4. When building-up sub-assemblies each component part should be lubricated with clean transmission fluid. It is also good practice to lubricate the sub-assemblies as they are installed in the case.
5. Needle bearings, thrust washers and seals should be lightly coated with petroleum jelly during sub-assembly build-up or transmission assembly.
6. Many components and surfaces in the transmission are precision machined. Careful handling during disassembly, cleaning, inspection and assembly can prevent unnecessary damage to machined surfaces.
7. When building-up sub-assemblies or assembling the transmission always use new gaskets and seals.
8. The transmission repair area should be kept clean, well organized and supplied with clean lint-free shop cloths.
9. Whenever a seal is removed from a piston, shaft or servo, note the type of seal and when applicable, the direction of the sealing lip.
10. Always use the specified transmission fluid when lubricating seals or other components prior to assembly (refer to Specifications for the proper fluid).

    NOTE: Do not soak oil filter in a solvent cleaner. The filter element could disintergrate. Replace the filter when necessary.

Transmission

Disassembly

Refer to Figs. 15, 16 and 17.

1. Mount the transmission in holding fixture, Tool T57L-500-B or equivalent.

   NOTE: Before removing any of the subassemblies, thoroughly clean the outside of the transmission to prevent dirt from entering the mechanical parts.

   During the repair of the subassemblies, certain general instructions which apply to all units of the transmission must be followed. These instructions are given here to avoid unnecessary repetition.

   Handle all transmission parts carefully to avoid nicking or burring the bearing or mating surfaces.

   Lubricate all internal parts of the transmission with transmission fluid before assembly. **DO NOT USE ANY OTHER LUBRICANTS EXCEPT ON GASKETS AND THRUST WASHERS WHICH MAY BE COATED WITH PETROLEUM JELLY TO FACILITATE ASSEMBLY. ALWAYS INSTALL NEW GASKETS WHEN ASSEMBLING PARTS OF THE TRANSMISSIONS.**

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Chart No.	Part No.	Description	Chart No.	Part No.	Description	Chart No.	Part No.	Description	Chart No.	Part No.	Description
1	7902	Torque converter	40	7F207	Forward clutch cylinder & turbine shaft	81	7F273	Output shaft large (4) steel seal rings #7, #8, #9, #10	125	7F250	2-3 accumulator valve seal (small)
2	7F208	Direct drive shaft							126	7F251	2-3 accumulator valve
3	7A248	Front pump seal	41	7F227	Forward clutch piston seal (outer)	82	7D164	Output shaft hub	127	7F249	2-3 accumulator valve seal (large)
4	7D441	Front pump "O" ring	42	7F228	Forward clutch piston seal (inner)	83	97713	Retaining snap ring (O.P.S. hub to O.P.S.)	128	7F285	2-3 accumulator valve return spring
5	7A103	Front pump body	43	7L140	Forward clutch piston				129	7F252	2-3 accumulator cover
6	7A136	Front pump gasket	44	7F230	Forward clutch piston return spring	84	7C122	Retaining snap ring (O.P.S. hub to ring gear)	130	388492	Retaining snap ring (2-3 accum. to case)
7	7C010	Front pump drive gear	45	7F229	Return spring retainer						
8	7C011	Front pump driven gear	46	388099	Retaining snap ring	85	7E110	Rear case bushing	131	7D071	Park pawl shaft
9	7A108	Stator support — front pump	47	7E085	Waved spring	86	7F242	#9 needle bearing (rear case)	132	7D419	Guide cup
10	7F225	Interm. clutch piston inner lip seal	48	7B442	Forward clutch external spline steel plate	87	7005	Case assy.	133	7D070	Park pawl return spring
11	7F224	Interm. clutch piston outer lip seal				88	7A247	Neutral start switch	134	7F338	Manual lever
12	7B258	Front pump bushing	49	7E311	Forward & reverse clutch internal spline friction plate	89	7034	Vent cap	135	7341	Grommet
13	7E005	Interm. clutch piston				90	7A189	Governor counterweight	136	7F337	Throttle lever oil seal
14	7F222	Interm. clutch piston return springs & retainer	50	7F278	Forward & reverse clutch pressure plate	91	70063	Body assy. — governor	137	N62004-S51	Attaching nut & lock washer — M8 x 1.25
						92	7A303	Plug governor	138	7F291	Throttle lever (outer)
15	7F220	Interm. clutch external spline steel plates (sel.)	51	7D483	Retaining snap ring (selective)	93	7A304	Sleeve governor	139	7A441	Park pawl
			52	7G040	#3 needle bearing (fwd. clutch)	94	7E242	Screen assy. — gov. oil	140	7A232	Park pawl actuating rod
16	7F219	Interm. clutch internal spline friction plates	53	7D051	Forward clutch hub	95	7A302	Spring gov. valve	141	7A115	Manual lever (inner)
			54	7F244	#4 needle bearing	96	7C054	Valve governor	142	7B210	Roll pin — 1/8 x 0.95 grooved
17	7F226	Interm. clutch pressure plate	55	7A019	Reverse sun gear & drive shell assy.	97	7A300	Body governor	143	7E332	Detent spring
18	7D014	#1 thrust washer (front pump) selective	56	7F244	#5 needle bearing	98	N800273	Bolt (governor body to counterweight)	144	N800287-S51	Attaching nut (manual LVR) — M14 x 1.5 HEX
			57	7A399	Forward sun gear	99	7A305	Clip — governor spring retainer			
19	7F275	Stator support seal rings (rev. clutch) #1 and #2	58	388501	Center support retaining ring	100	N800274	Bolt (governor cover to governor body)	145	7F290	Throttle lever (inner)
			59	7F209	Forward sun gear precision bushing				146	7F292	Throttle torsion spring
20	7F276	Stator support seal rings (fwd. clutch) #3 and #4	60	7C363	Center support planetary	101	7A301	Cover — governor valve body	147	7F282	Valve body reinforcement plate
			61	7504	Planetary OWC cage spring & roller assy.	102	388104	Retaining snap ring (governor assy. to O.P.S.)	148	7C155	Separator plate gasket (upper)
21	7F196	Overdrive band							149	7A008	Separator plate
22	389790-S	Interm. OWC retaining snap	62	7A398	Planetary assy.	103	7086	Extension housing gasket	150	7D100	Separator plate gasket (lower)
23	7F262	Interm. OWC retaining plate	63	7D095	Reverse band	104	7A034	Extension housing bushing	151	7A100	Valve body (main control)
24	7F221	Interm. OWC outer race	64	7F236	Direct clutch hub	105	7A039	Extension housing	152	7F003	Filter & grommet assy. - oil pan
25	7F271	Interm. one-way clutch assy.	65	7F243	#7 needle bearing (direct clutch inner)	106	7052	Extension housing seal	153	7A191	Oil pan gasket
26	7F215	Reverse clutch drum				107	N803747-S100	Bolt (ext. hsg. to case) M6-12.5 x 30 (6 req'd)	154	7A264	Oil pan
27	7D403	Reverse clutch piston seal (outer)	66	388065-6-7-8	Retaining snap ring (selective)				155	390233-S2	Bolt (oil pan to case) — M8 x 1.25 x 15 (17 req'd)
28	7E079	Reverse clutch piston	67	7F237	Thrust spacer	107A	N803352-S100	Stud (ext. hsg. to case) M8-1.25 x 54 (2 req'd holes 1 and 6)②			
29	7D404	Reverse clutch piston seal (inner)	68	7B477	Direct clutch pressure plate				156	7E062	Oil filter gasket
30	7D256	Thrust ring	69	7E313	Direct clutch internal spline plates	108	376649	Pipe plug — 1/8-27 dry seal	157	N605775-S	Bolt (valve body to case) — M6-1.0 x 30 (8 req'd).
31	7D405	Reverse clutch piston return spring	70	7F238	Direct clutch external spline plates	109	7F201	Overdrive servo piston return spring			
32	7D406	Retaining snap ring	71	388104	Retaining snap ring	110	7F200	Overdrive servo piston	158	N606022-S	Bolt (valve body to case) — M6-1.0 x 40 (17 req'd)
33	7B066	Reverse clutch front pressure plate	72	7F235	Return spring & retainer	111	See Note	Overdrive servo piston seal			
34	7E311	Reverse clutch internal spline friction plate	73	7F254	Direct clutch piston	112	388515-S100	Overdrive servo cover seal rings	159	N605772-S	Bolt (screen to valve body) — M6-1.0 x 16 (3 req'd)
			74	7F234	Direct clutch piston seal (inner)	113	7F204	Overdrive servo cover			
35	7B442	Reverse clutch external spline steel plate	75	7C000	Direct clutch piston seal (outer)	114	388216	Retaining snap ring (O/D servo to case)	160	353351-S	Ball (governor drive)
			76	7A153	Ring gear & park gear				161	7F277	Spring (anti clunk)
36	7F278	Forward and reverse clutch pressure plate	77	7F283	Direct cylinder	115	7D031	Reverse servo piston return spring	162	7F434	Grommet
			78	7F284	Output shaft small (2) Teflon seal rings (direct clutch) #5 and #6	116	7D030	Reverse servo piston (selective)	163	7B498	Oil seal assy. Manual lever
37	7D483	Reverse clutch retaining ring (sel.)				117	7D281	Reverse servo cover	164	—	Overdrive anchor-pin — not serviced
38	7D076	#2 thrust washer (rev. clutch)①	79	7F240	#8 needle bearing (direct clutch outer)	118	388215	Retaining snap ring (rev. servo to case)	165	N605789-S100	Bolts (front pump to case — 7 req'd)
38A	7A166	#2 Needle bearing (rev. clutch)①							166	N804799-S100	Connector assy. (cooler line) 5/16 tube x 1/4 external pipe
39	7F212	Turbine shaft	80	7060	Output shaft						

① Some Applications
② Sealant Coated

CD3935-2G

FIG. 15 Automatic Overdrive Transmission—AOD—Exploded View—4x2 Vehicles

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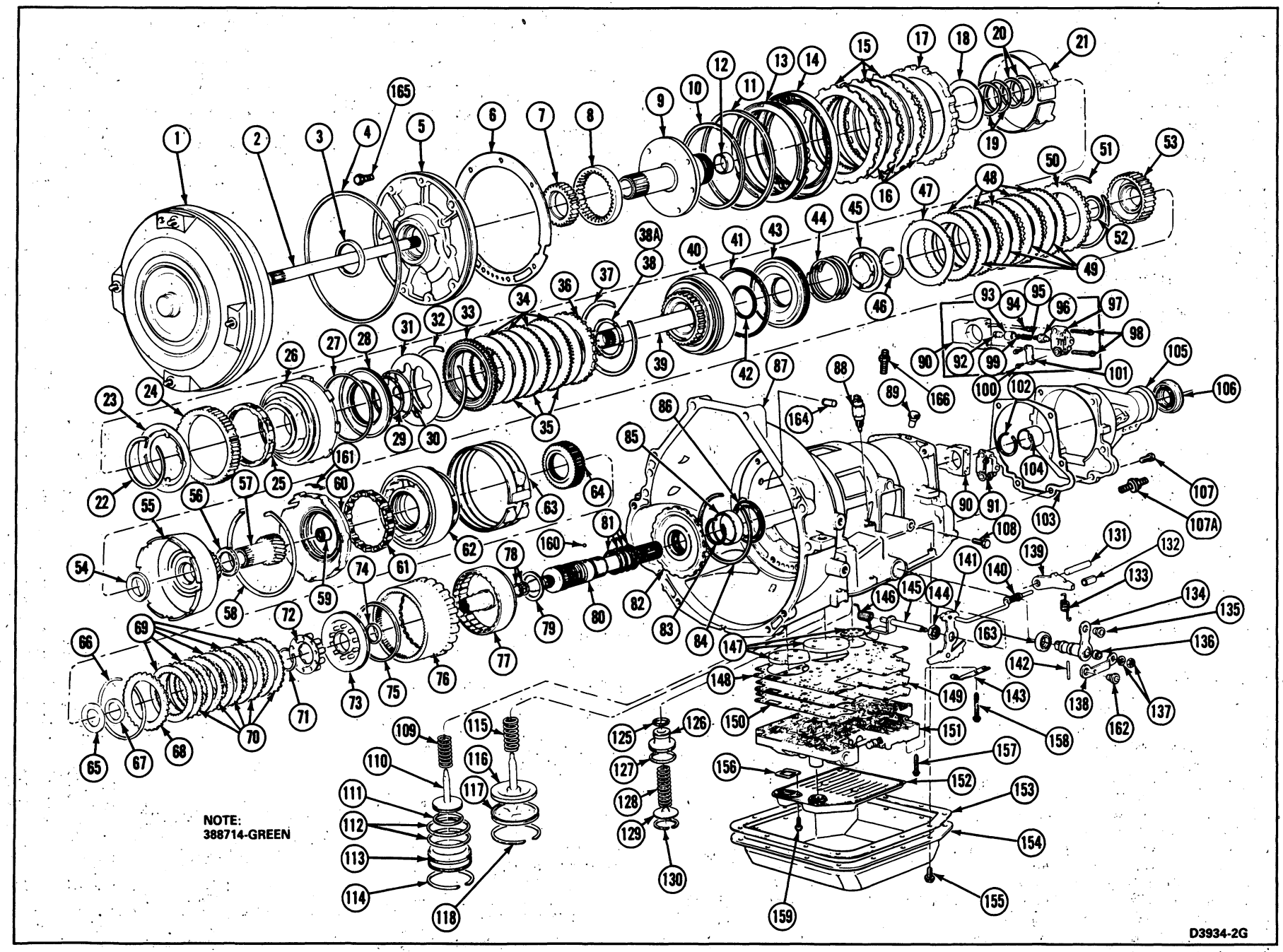


FIG. 16 Automatic Overdrive Transmission—AOD—Exploded View 4x4 Vehicles

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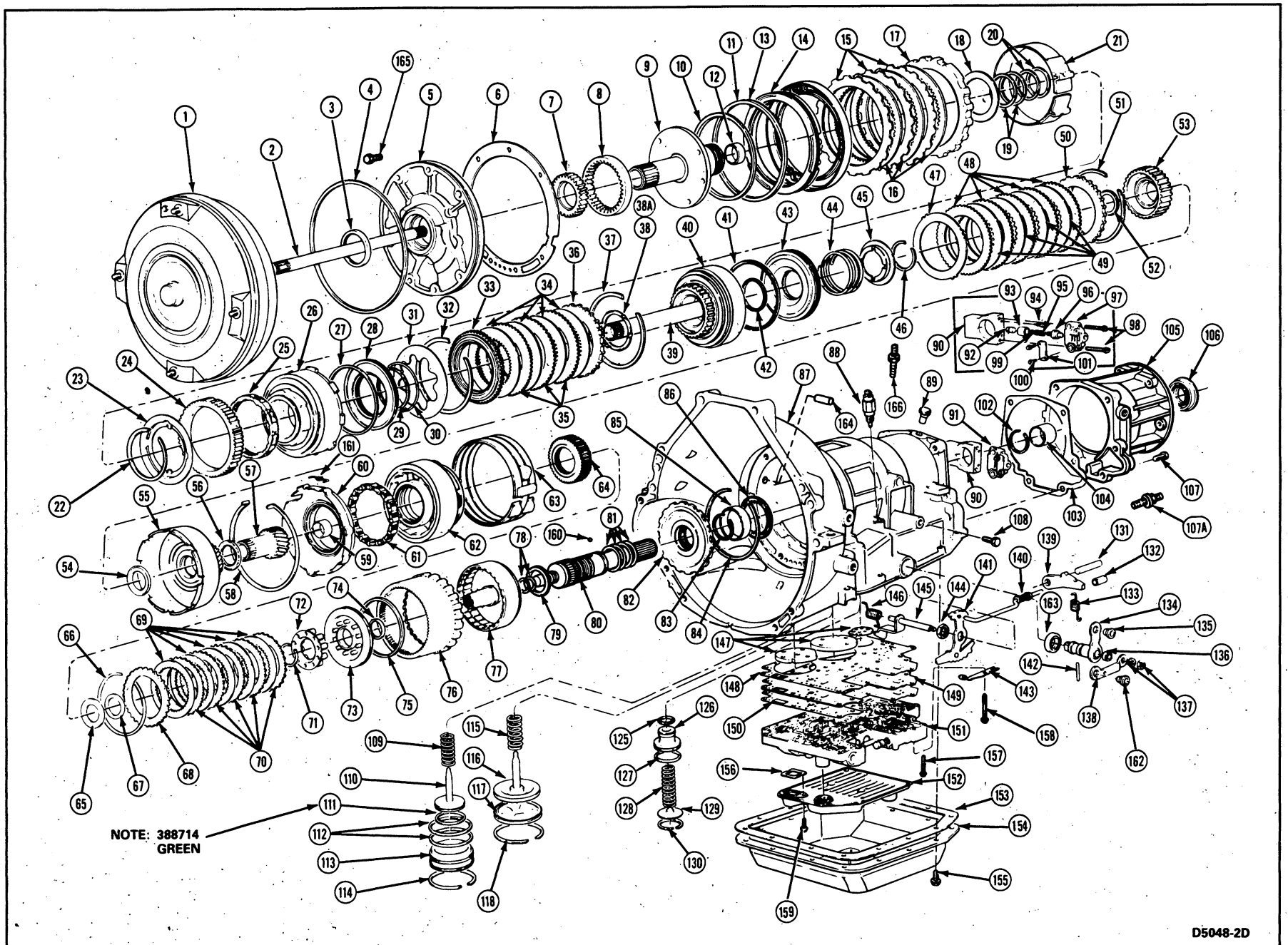


FIG. 17 Automatic Overdrive Transmission—Nomenclature

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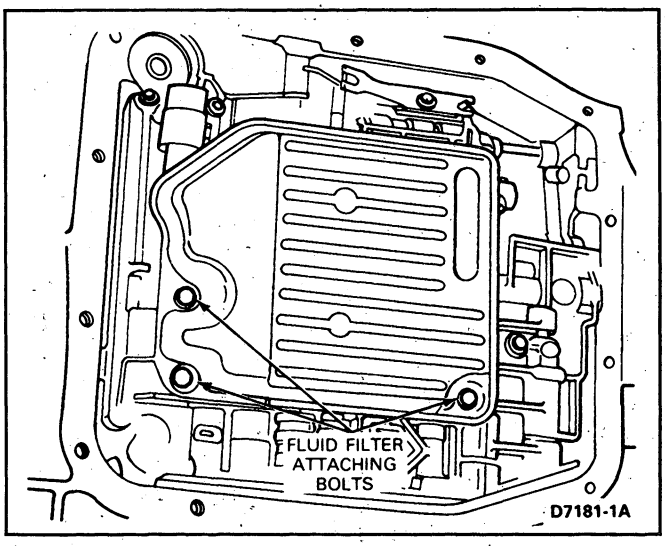


FIG. 18 Fluid Filter

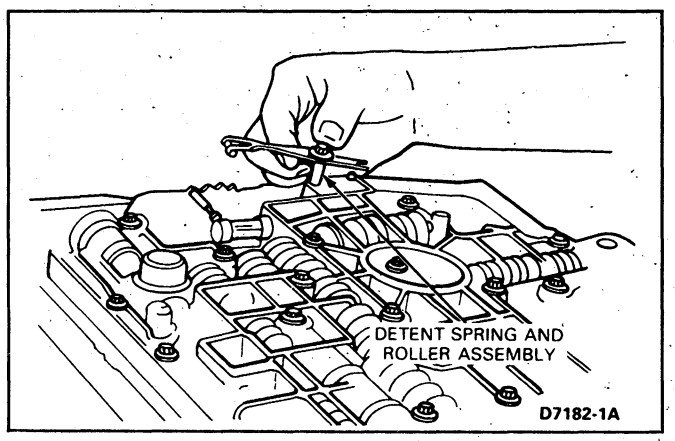


FIG. 19 Removing Shift Spring and Roller Assembly

Tighten all bolts and screws to the recommended torque as listed on Specifications in this Section. For detail cleaning and inspection operations, refer to Section 17-01 General Automatic Transmission Service.

2. Remove the torque converter by grasping firmly and pulling straight out of the transmission.
3. Remove the 14 oil pan attaching bolts, the oil pan and the pan gasket. Discard the gasket.
4. Remove the three fluid filter attaching bolts (Fig. 18). Remove the filter grommet and gasket. Discard the gasket.
5. Remove the shift linkage detent spring and roller assembly (Fig. 19).
6. Remove the remaining (25) valve body-to-case attaching bolts, the valve body assembly and the valve body gasket.

   NOTE: The (4) front, (1) center and (3) rear attaching bolts are shorter than the others as indicated by a circle (Fig. 90).
7. Push down on the 3-4 accumulator cover (Fig. 21) and remove the retaining ring using a thin-bladed screwdriver.
8. Remove the 3-4 accumulator cover. If the cover sticks in the bore, use Servo Piston Remover, T80L-77030-B (or equivalent) and air pressure to aid removal (Fig. 21).

   CAUTION: Make certain a portion of Servo Piston Remover T80L-77030-B (or equivalent) extends over the bore to prevent the cover from flying out of the bore.
9. Remove the 3-4 accumulator piston.

   The piston uses a scarf-cut teflon seal and comes out with very little resistance.

   NOTE: Some models may use a spring. The piston and spring may be different from that shown.
10. Using a wide-bladed screwdriver or wooden dowel, push down on the 2-3 accumulator cover and remove the retaining ring (Fig. 21).
11. Remove the 2-3 accumulator cover and the piston spring.
12. Remove the 2-3 accumulator piston. The piston uses two scarf-cut teflon seals and comes out with very little resistance.
13. Using a hammer handle or wooden dowel, push down on the low-reverse servo cover and remove the snap ring (Fig. 20).
14. Remove the low-reverse servo cover, servo piston and the piston return spring. If necessary, a magnet can be used to lift the piston from the bore.

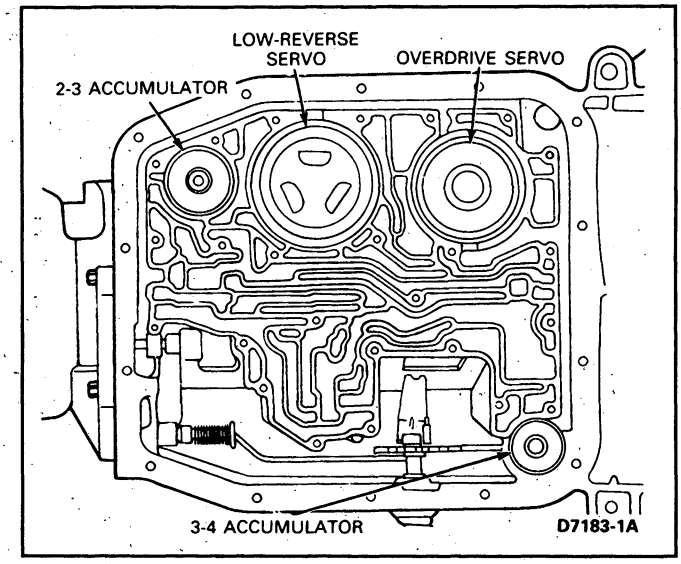


FIG. 20 Accumulator and Servo Locations

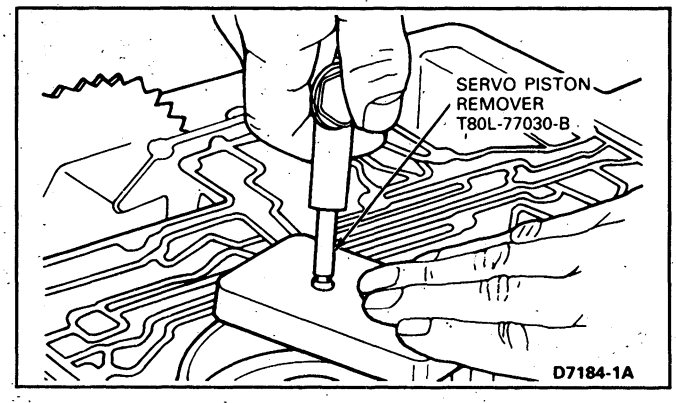


FIG. 21 Removing 3-4 Accumulator Cover

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15. Using a hammer handle or wooden dowel, push down on the over-drive servo cover and remove the snap ring (Fig. 20).
16. Remove the overdrive servo cover and piston as a unit. If the cover sticks in the bore, use Servo Piston Remover T80L-77030-B (or equivalent) and air pressure to aid removal (Fig. 21). Remove spring.

    CAUTION: Make certain a portion of Servo Piston Remover T80L-77030-B (or equivalent) extends over the bore to prevent the cover from flying out of the bore.
17. Remove the direct drive shaft (Fig. 22).

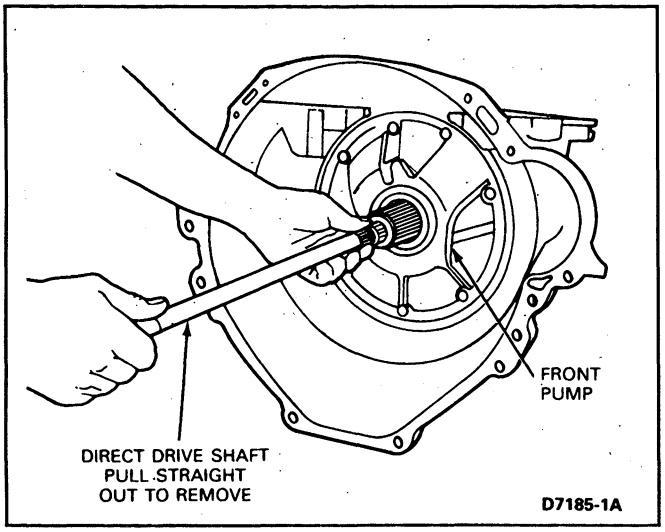


FIG. 22 Removing or Installing Direct Drive Shaft

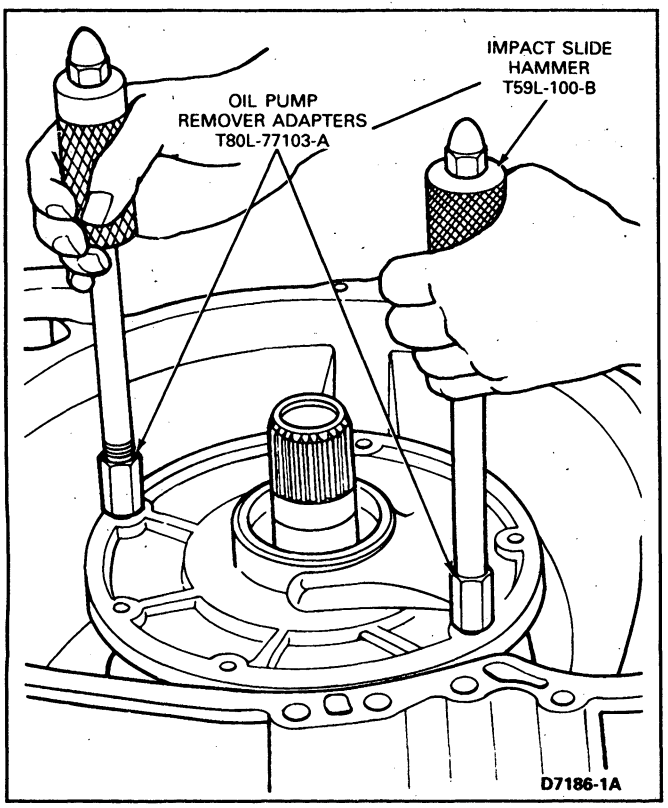


FIG. 23 Removing Front Oil Pump

18. Remove the (7) pump body attaching bolts.
19. Remove the pump assembly using Slide Hammers T59L-100-B and oil pump remover Adapters T80L-77103-A as shown in Fig. 23.
20. Remove the pump-to-case gasket.
21. Grasp the turbine shaft firmly and pull these components (Refer to Fig. 15) out of the case as an assembly:
    a. Intermediate clutch pack
    b. Intermediate one-way clutch
    c. Reverse clutch
    d. Forward clutch

    Use care not to damage the overdrive band friction liner material with the Reverse clutch drive lugs.
22. Disengage the overdrive band from the anchor pins and remove from the case (Fig. 24).
23. Remove the forward clutch hub and the No. 3 needle bearing as an assembly.
24. Remove the forward sun gear, the No. 5 needle bearing, the reverse sun gear and drive shell and the No. 4 needle bearing as an assembly.
25. Remove the center support snap ring.

    Note position of tabs for assembly.
26. Using a screwdriver, pry the anticlunk spring out from between the center support and the case.

    Note the location for assembly.
27. Remove the center support and planetary carrier as an assembly.
28. Remove the reverse band.
29. If the direct clutch hub did not come out with the planetary carrier, reach in and lift it out of the direct clutch.
30. Remove the (6) extension housing attaching bolts and the extension housing. Remove and discard the extension housing gasket.

NOTE: The extension housing bolts have been coated with a sealant. More break torque may be required to remove these bolts.

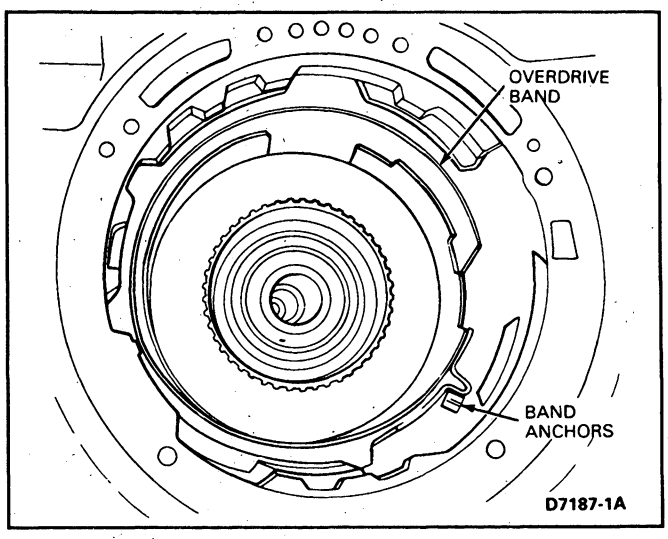


FIG. 24 Removing Overdrive Band

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31. Remove the retaining ring and governor assembly (Fig. 25).

    NOTE: If the transmission is positioned with the output shaft pointing up, do not allow the shaft assembly to fall through the case when the governor is removed.

32. Remove the governor drive ball from the output shaft. A magnet may be used to aid removal.
33. Remove the output shaft, the ring gear and the direct clutch as an assembly, through the front of the case (Fig. 26).
34. Remove the output shaft No. 9 needle bearing from the rear of the case.
35. Remove the intermediate one-way clutch.
36. Remove the reverse clutch assembly from the forward clutch assembly.

Sub-Assemblies

Governor

Refer to Fig. 27.

Disassembly

1. Remove the screws attaching the counterweight to the governor body.
2. Remove the cover screws and cover.
3. Remove the plug, the sleeve, and the valve from the governor body.

Assembly

1. If removed, reinstall the clip and spring on the valve.
2. Install the valve in the governor body.
3. Install the sleeve in the governor body with the points outward.
4. Install the plug in the sleeve with the knurled face inward.
5. Attach the cover. Tighten the screws to 2.3-3.4 N·m (20-30 in-lbs).
6. Position the governor body to the counterweight and install the screws. Tighten the screws to 6-7 N·m (50-60 in-lbs). The finished face of the body should be flush with the face of the counterweight. (If it is not, the body is installed backwards).

Parking Pawl

Refer to Fig. 28.

Dissassembly

1. Slide the park pawl shaft out the rear of the case and remove the parking pawl.
2. Remove the return spring.

Assembly

1. Hook the squared end of the spring into the notch on the park pawl.
2. Hold pawl and spring in place and hook curved end of spring into the recess in the case.
3. Install the park pawl shaft.

Intermediate One-Way Clutch

Refer to Fig. 29.

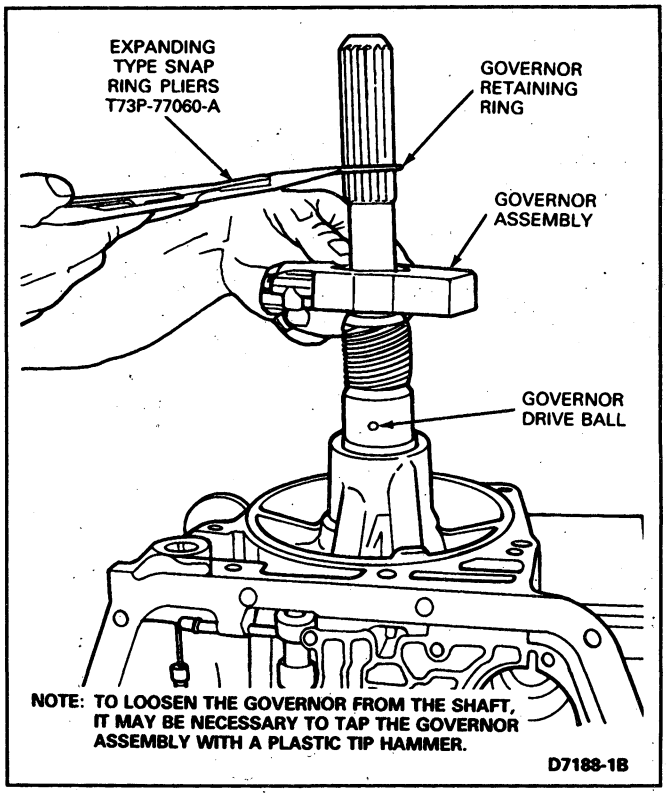


FIG. 25 Removing Governor

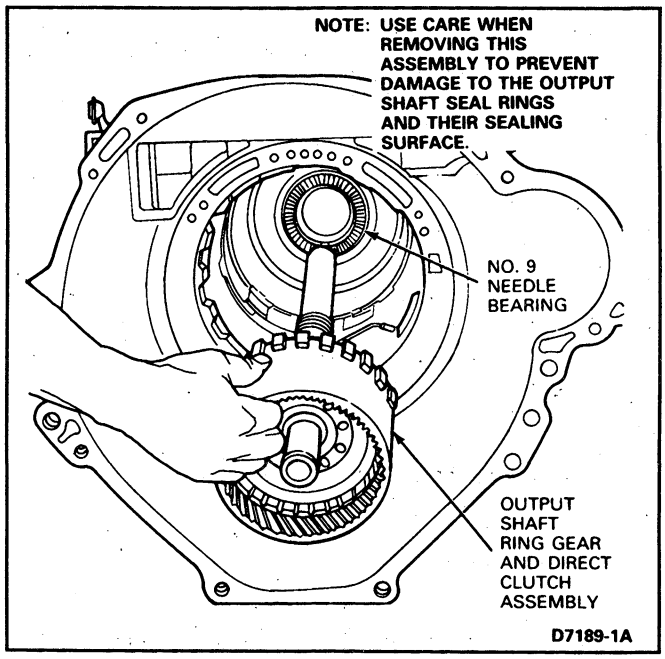


FIG. 26 Remove Output Shaft, Ring Gear and Direct Clutch Assembly

Disassembly

1. Using snap ring pliers, remove the clutch retaining ring.
2. Remove the clutch retaining plate.
3. Remove the clutch outer race by lifting on the race while turning counterclockwise.
4. Carefully lift the one-way clutch from the inner race.

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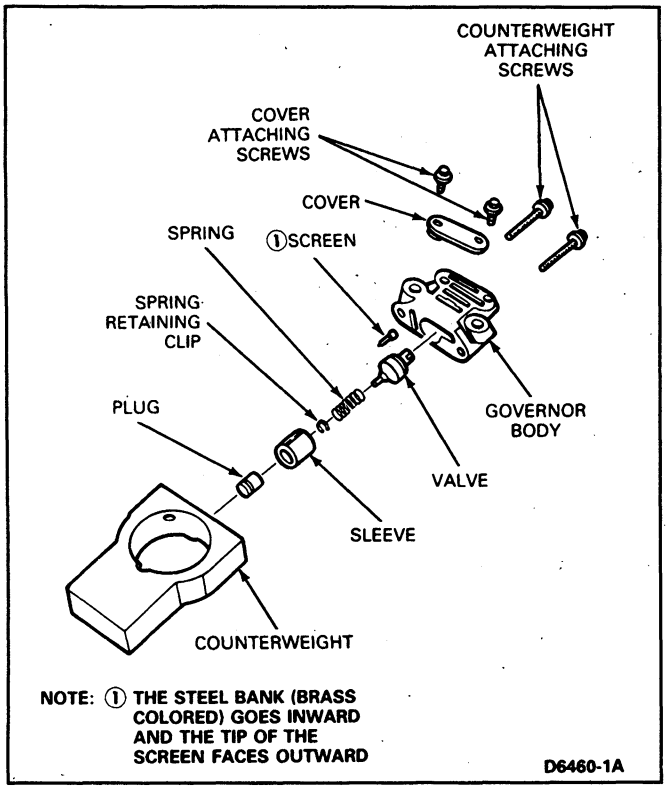


FIG. 27 Governor—Exploded View

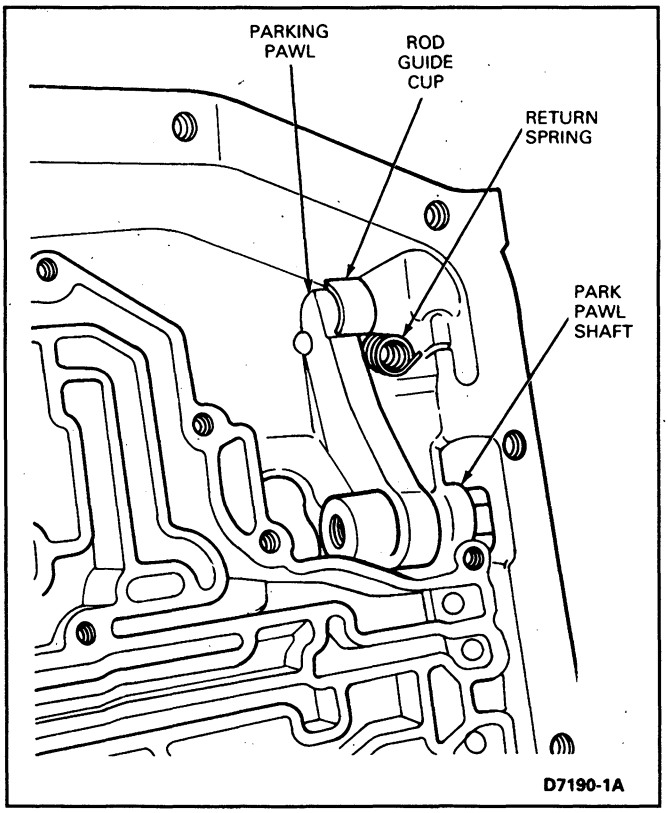


FIG. 28 Parking Pawl

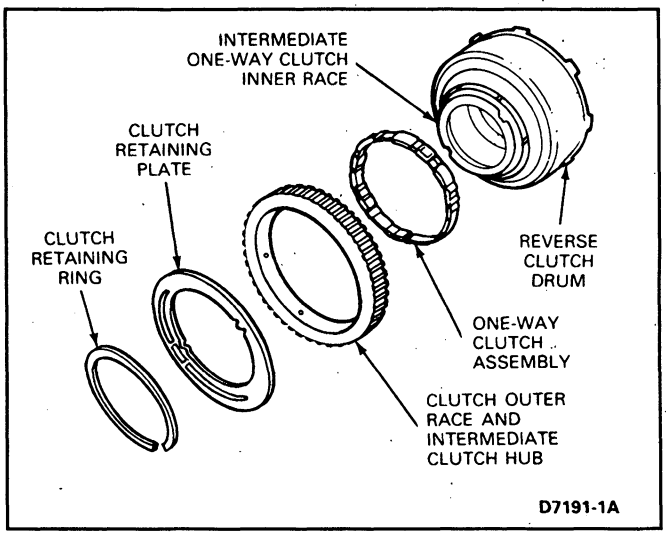


FIG. 29 Intermediate One-Way Clutch-Exploded View

Assembly

To assemble the intermediate one-way clutch, reverse the disassembly procedure.

Output Shaft

Refer to Fig. 30.

Disassembly

1. Remove the ring retaining the output shaft hub to the ring gear.
2. Separate the output shaft and hub assembly from the ring gear.
3. Remove the direct clutch from the ring gear and the No. 8 needle bearing from the back of the direct clutch.
4. Remove the four output shaft seal rings and the hub-to-output shaft retaining ring. Separate the hub from the output shaft.
5. Remove the two direct clutch seal rings from the output shaft.

Assembly

To assemble the output shaft, reverse the disassembly procedure.

Manual and Throttle Linkage

Refer to Fig. 31.

Disassembly

1. Grasp the outer throttle lever firmly and loosen the lever attaching nut (13mm). Remove the attaching nut, the lockwasher, and throttle lever.

   NOTE: The outer throttle lever must be held in the position shown in Fig. 32 to prevent the inner throttle lever from rotating against the machined valve body surface. Failure to observe this precaution could result in damage to the valve body surface.

2. Using a small screw driver or awl, remove the seal from the outer manual lever counterbore.

   Discard seal.

3. Using a pair of diagonal cutters, remove the manual shaft retaining pin from the case.
4. Grip the inner manual lever with an adjustable wrench and loosen the lever attaching nut (20mm). Thread the nut off the shaft and remove the lever.
5. Remove the inner throttle lever and torsion spring.

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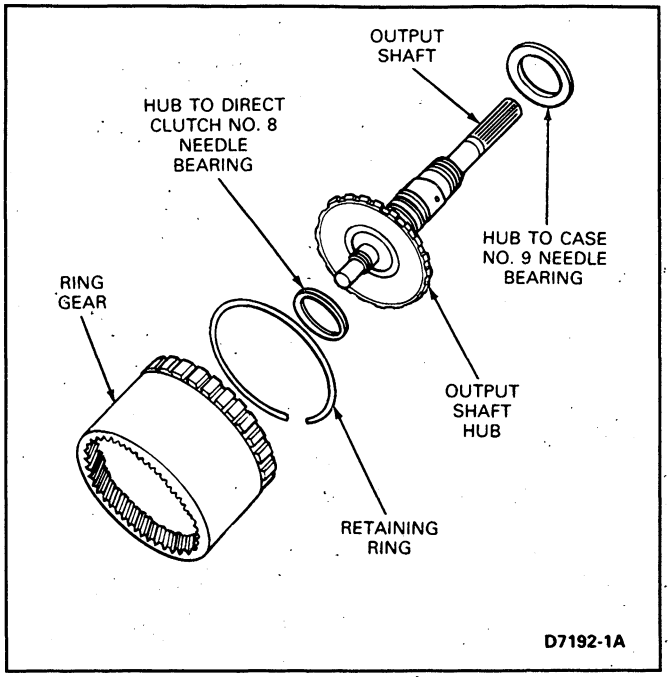


FIG. 30 Output Shaft—Exploded View

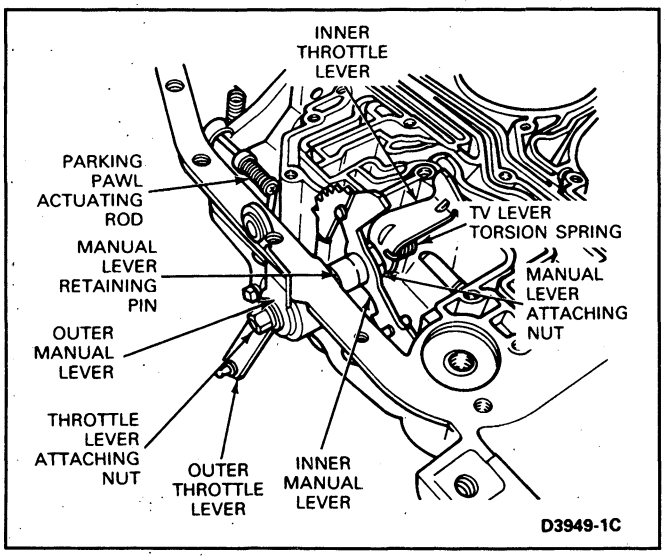


FIG. 31 Manual and Throttle Linkage

6. Remove the inner manual lever and parking pawl actuating rod as an assembly. After removal, the rod may be disengaged from the lever.
7. Remove the manual lever shaft seal from the case using seal remover Tool T58L-101-B (or equivalent) as shown in Fig. 33.

   Discard seal.

Assembly

To assemble the manual and throttle linkages, reverse the disassembly except for the following:

1. Install a new manual lever seal using Seal Installer T74P-77498-A or equivalent tool as shown in Fig. 34.
2. Before installing the outer throttle lever, install a new seal in the outer manual lever (Fig. 35). A 13mm thin wall socket may be useful, using the

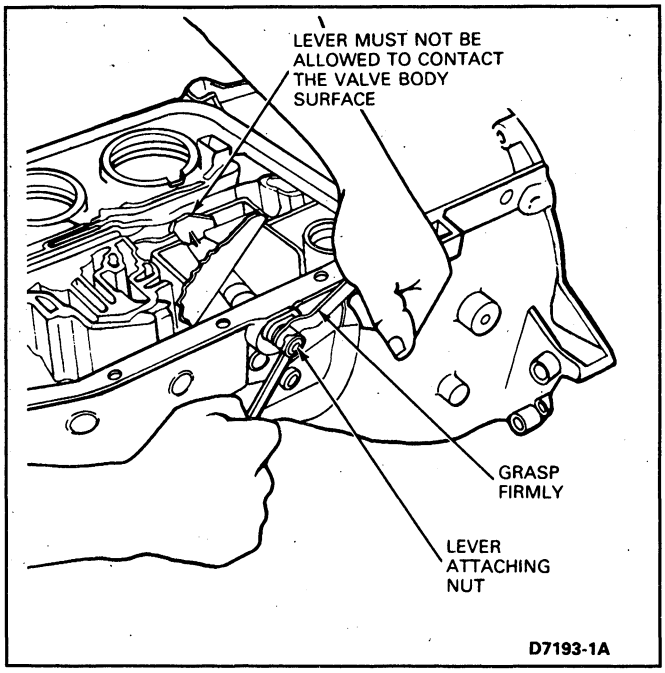


FIG. 32 Removing Outer Throttle Lever

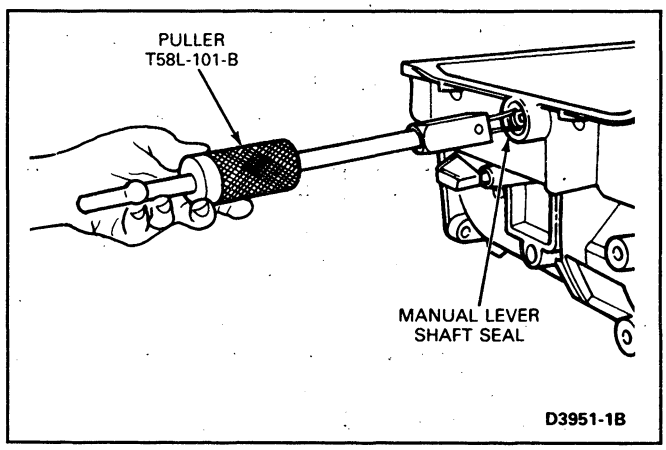


FIG. 33 Removing Manual Lever Shaft Seal

end that the ratchet drive would be inserted into, to seat the seal.

NOTE: The seal identification number must face outward.

Direct Clutch

Refer to Fig. 36.

Disassembly

1. Remove the No. 7 direct clutch hub inner needle bearing and bearing support.
2. Remove the clutch pack selective retaining ring.
3. Remove the clutch pack from the drum.
4. Using Clutch Spring Compressor Tool T65L-77515-A (or equivalent), compress the piston return springs and remove the retaining ring (Fig. 37).
5. Remove the spring retainer assembly and piston from the drum. (Use air pressure, if necessary to remove piston.) Make sure the ball check in piston

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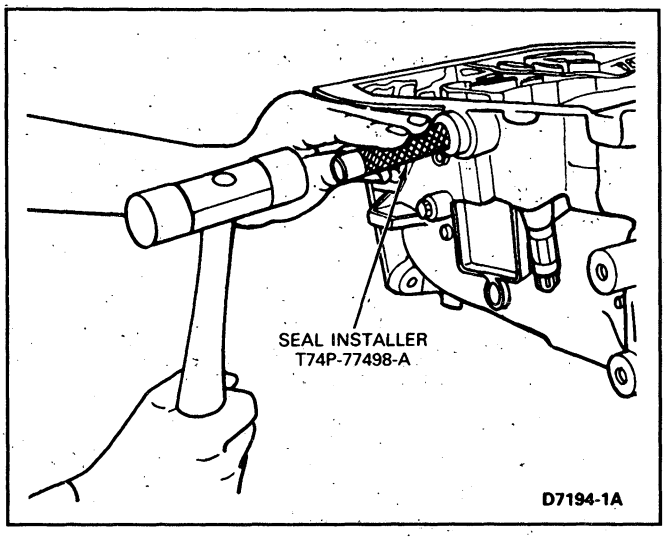


FIG. 34 Installing Manual Lever Seal

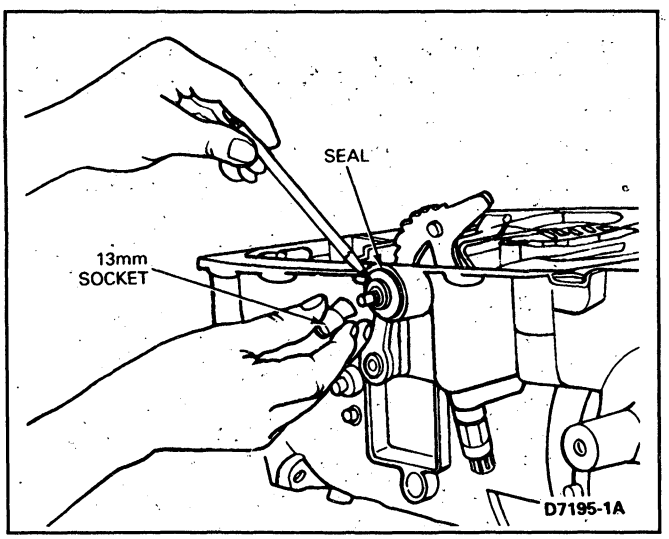


FIG. 35 Installing Outer Throttle Lever Seal

is free. Note the position and direction of the lip seals and then remove them.

6. Inspect the direct clutch piston check ball (Fig. 38). Perform the direct clutch piston check ball leakage procedure as described in Section 17-01, Automatic Transmission General Service.

Assembly

1. Install a new inner piston seal on the clutch drum hub as follows:
   a. Position Seal Protector T80L-77234-A or equivalent over the clutch drum hub (View A, Fig. 39).
   b. Lubricate the seal and the seal protector with petroleum jelly.
   c. Position the seal over the installer tool with the sealing lip facing down (View B, Fig. 39).
   d. Push the seal down until it snaps off the end of the protector onto the clutch hub.
   e. Remove the seal protector from the clutch hub.
   f. Slide the seal up until it seats in the seal groove.

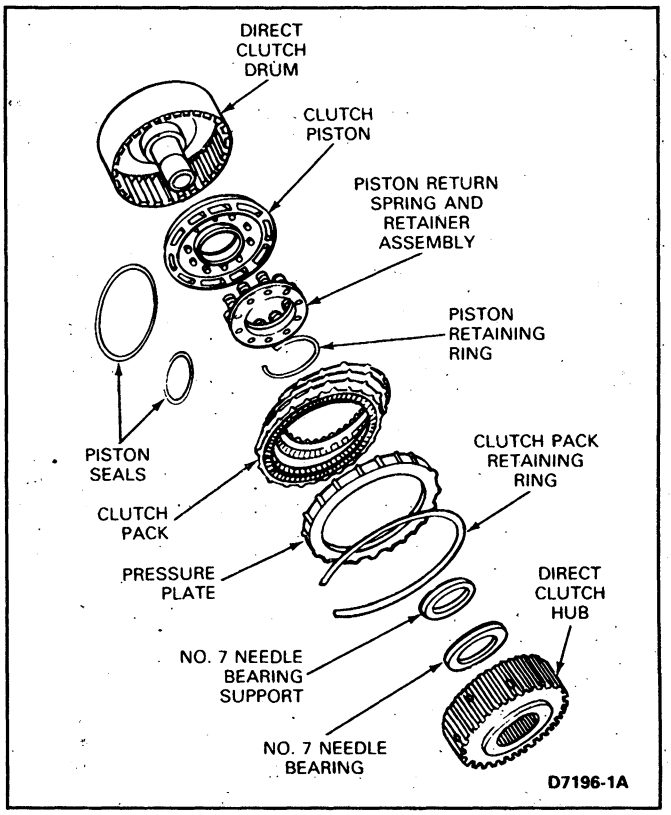


FIG. 36 Direct Clutch—Exploded View

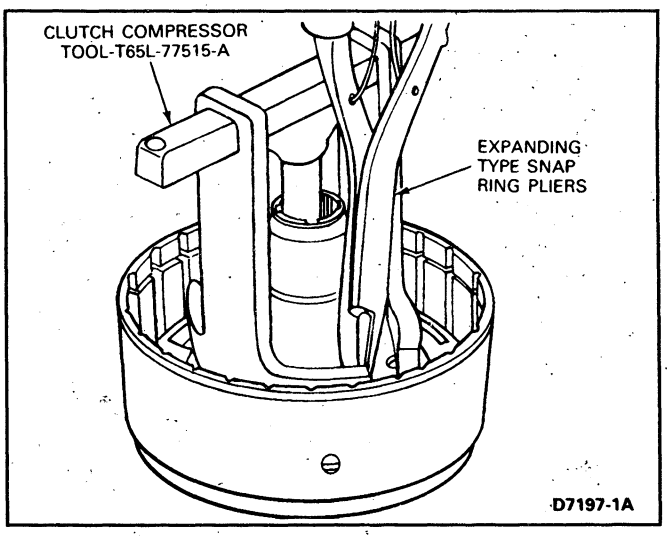


FIG. 37 Removing Direct Clutch Retaining Ring

2. Install a new outer clutch piston seal. Note the direction of the sealing lip before installation. The lip points away from the spring posts.
3. Install the clutch apply piston as follows:
   a. Coat the piston seals, the clutch drum sealing area, and the piston inner seal area with petroleum jelly.
   b. Install the piston in Seal Protector T80L-77254-A (or equivalent) as shown in Fig. 40.
   c. Position the tool in the clutch drum and push the piston to the bottom of the drum using even thumb pressure.

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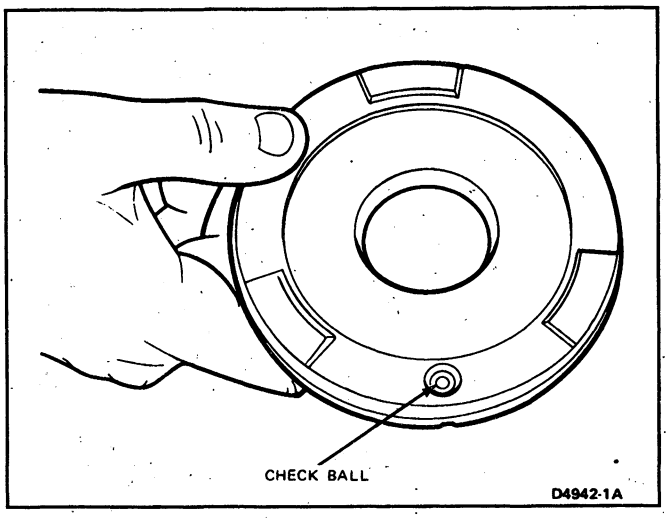


FIG. 38 Direct Clutch Piston

4. Install the piston spring and retainer assembly and retaining ring using compressor Tool T65L-77515-A or equivalent.
5. Install the clutch pack.
6. Install the clutch pack selective retaining ring and check the clearance between the ring and the pressure plate. The pressure plate should be held downward as the clearance is checked. The clearance should be: 4.9L (300 CID) EFI Engine, and the 5.0L (302 CID) EFI Engine 1.27-1.77mm (0.050-0.067 inch). If the clearance is not within limits, selective snap rings are available in the following thicknesses: 0.050 to 0.054, 0.064 to 0.068, 0.078 to 0.082 and 0.092 to 0.096 inch. Install the correct size snap ring and recheck the clearance.
7. Check the clutch for proper operation using air pressure. The clutch should be heard and felt to apply smoothly and without leakage.

Forward Clutch

Refer to Fig. 41.

Disassembly

1. Remove the clutch hub and No. 3 needle bearing, if not already removed.
2. Remove the clutch pack selective retaining ring.

   NOTE: To aid handling, the clutch may set in the extension housing or a 2 inch diameter hole may be cut in the work bench.
3. Remove the clutch pack.
4. Compress the piston return spring using Tool T65L-77515-A and forward clutch adapter Tool T80L-77515-A (or equivalent) (Fig. 42). Remove the retaining ring and spring retainer.
5. Remove the clutch piston.
6. Make sure that the two ball checks in forward clutch cylinder are free.
7. Note the position of the inner and outer piston seals, then remove them.

Assembly

1. Install new seals on the clutch piston. Note the direction of the sealing lip before installation (Fig. 43).
2. Install the clutch piston as follows:
   a. Coat the piston seals and the clutch drum sealing area with petroleum jelly.
   b. Install the inner seal protector, Tool T80L-77140-A or equivalent, over the clutch cylinder hub (Fig. 44).
   c. Install the piston in the outer seal protector, Tool T68P-7D158-A or equivalent (Fig. 44).
   d. Position the seal protector and piston in the clutch drum. Push the piston to the bottom of the drum using even thumb pressure.
3. Install the piston return spring, the spring retainer and the retaining ring. Compress the piston return spring using compressor Tool T65L-77515-A and forward clutch adapter Tool T80L-77515-A (or equivalent) as shown in Fig. 42.
4. Install the clutch pack. The wave plate must be installed first.

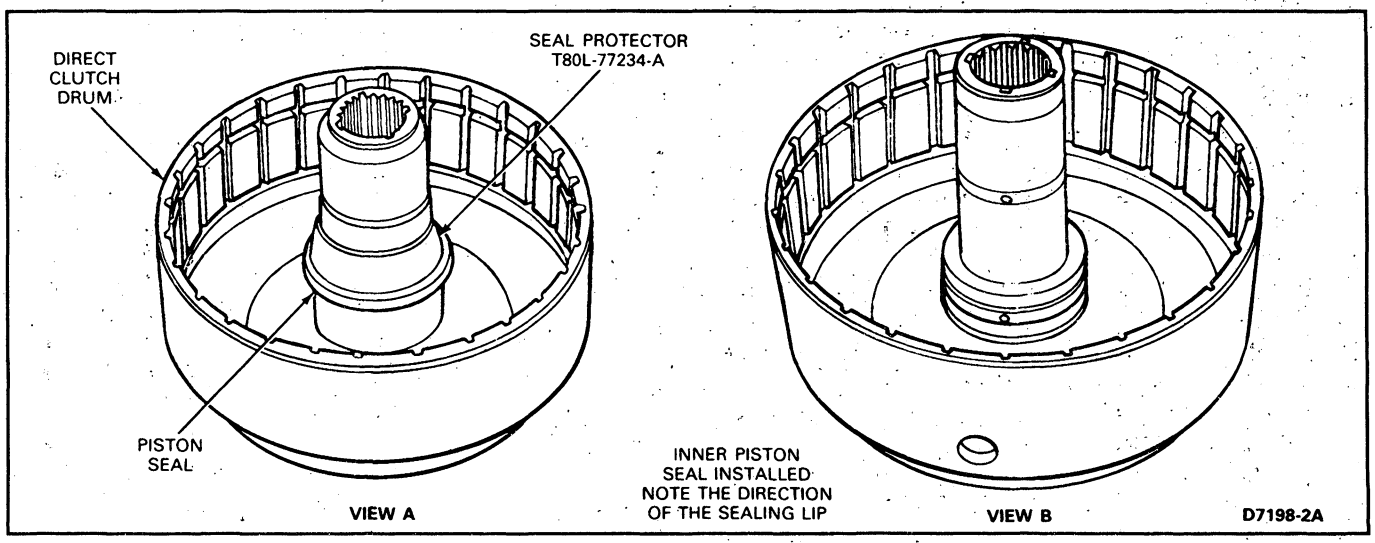


FIG. 39 Inner Piston Seal Installation

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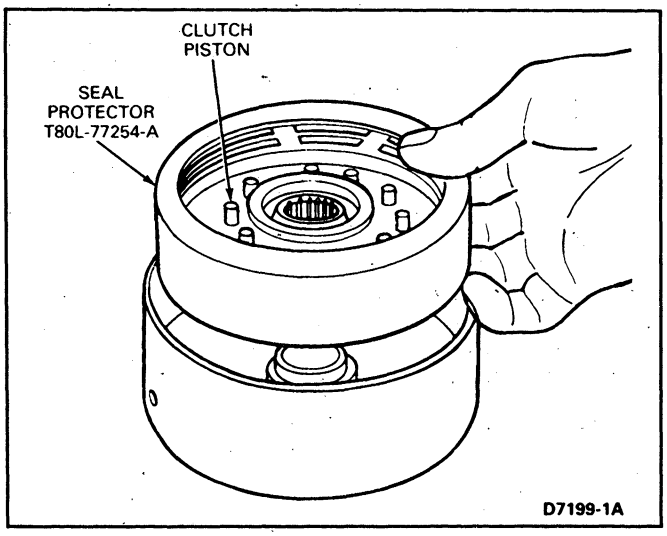


FIG. 40 Clutch Piston Assembly

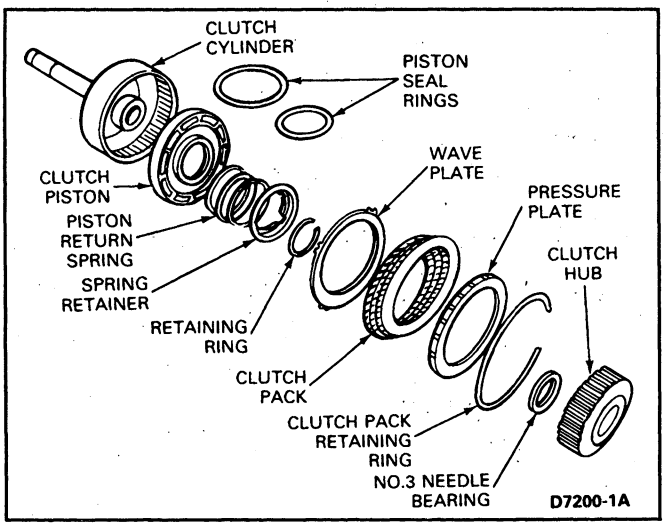


FIG. 41 Forward Clutch—Exploded View

5. Install the clutch pack retaining ring and check the clearance between the ring and the pressure plate. The pressure plate should be held downward as the clearance is checked.

   The clearance should be:

   4.9L (300 CID) EFI and

   5.0L (302 CID) EFI 1.27mm-2.26mm (0.050-0.089 inch)

   If the clearance is not within specifications, selective snap rings are available in the following thicknesses: 0.060 to 0.064, 0.074 to 0.078, 0.088 to 0.092 and 0.102 to 0.106 inch. Install the correct size snap ring and recheck the clearance.

6. Check the clutch for proper operation using air pressure. The clutch should be heard and felt to apply smoothly and without leakage.

Reverse Clutch

Refer to Fig. 45.

Disassembly

1. Remove No. 2 needle bearing (4x2) or No. 2 thrust washer (4x4).

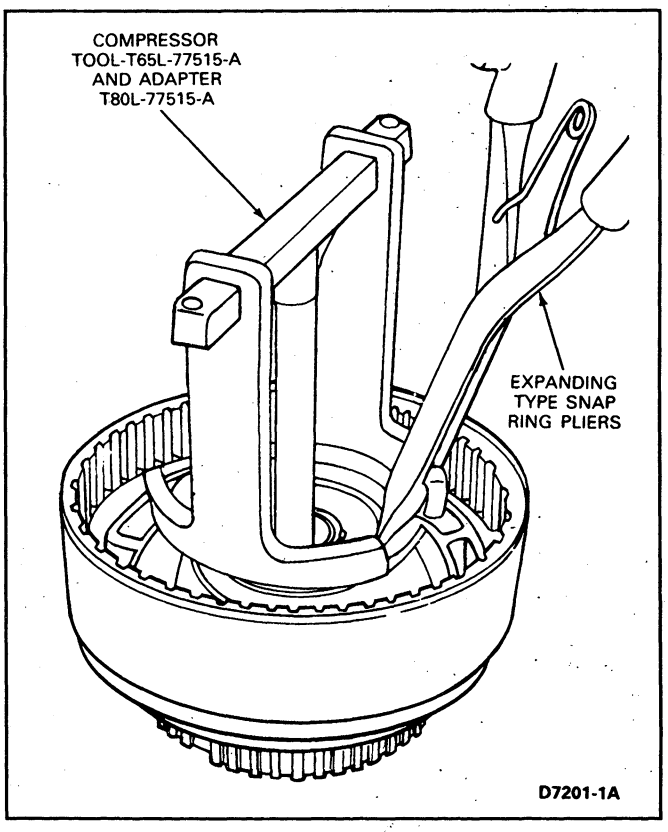


FIG. 42 Removing Forward Clutch Retainer Ring and Spring Retainer

   NOTE: 4x2 applications use a needle bearing. 4x4 applications use a thrust washer.

2. Remove the clutch pack retaining ring.
3. Remove the clutch pack.
4. Remove the wave snap ring using compressor Tool T65L-77515-A and adaptor Tool T80L-77405-A or equivalent (Fig. 46).
5. Remove the piston return spring and the thrust ring.
6. Remove the clutch piston.

   NOTE: To aid removal, apply air pressure to the drum. Block the opposite hole a with finger.

Assembly

1. Install new seals on the clutch piston. Because the seal is square cut, the direction of installation is not important.

   Be sure ball check in piston is free.

2. Install the clutch piston as follows:
   a. Coat the piston seals and clutch drum sealing area with petroleum jelly.
   b. Install inner seal protector, Tool T80L-77403-B and outer Seal Protector T80L-77403-A (or equivalent) in the clutch drum (Fig. 47).
   c. Coat the seal protector tools with petroleum jelly.
   d. Position the piston and push it to the bottom of the drum using even thumb pressure.
   e. Remove the seal protector tools.

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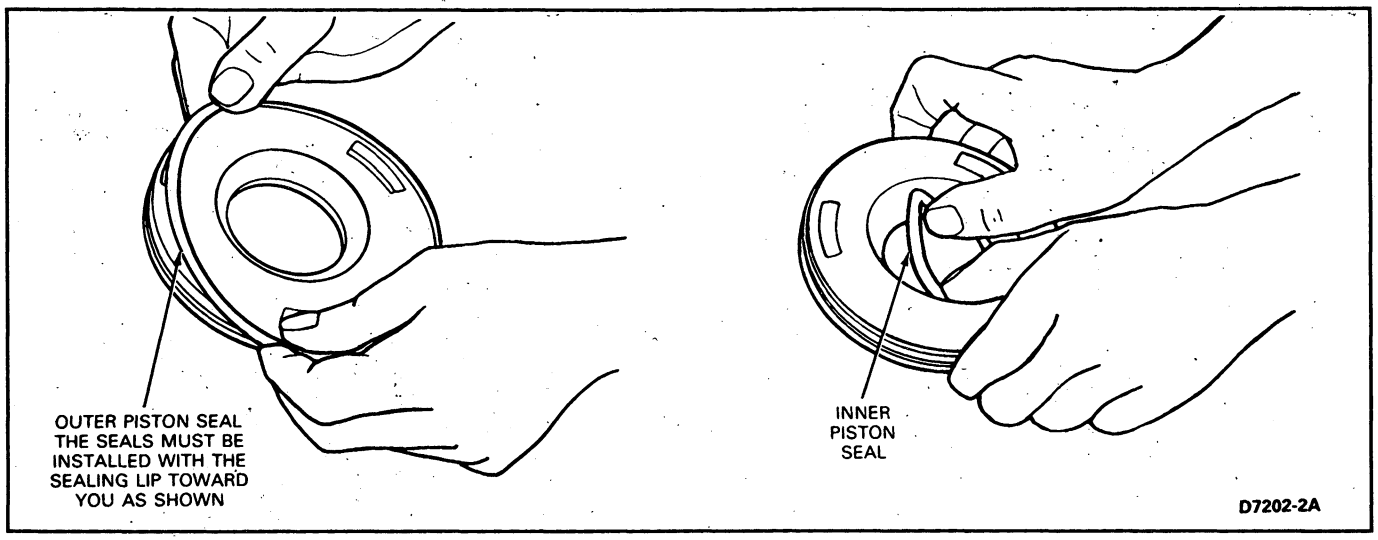


FIG. 43 Clutch Piston Seal Installation

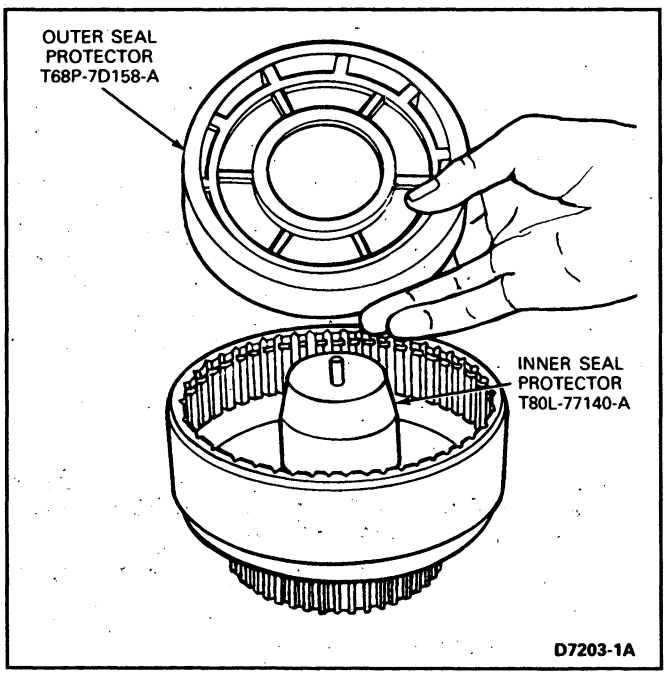


FIG. 44 Clutch Piston Assembly

3. Install the piston thrust ring and the piston return spring.
4. Install the wave snap ring (with points down) using compressor Tool T65L-77515-A and adaptor Tool T80L-77405-A (or equivalent) (Fig. 46).
5. Install the clutch pack. The apply plate must be installed first. Note that the dished side of the plate must face the piston.
6. Install the clutch pack retaining ring and check the clearance between the ring and the pressure plate. The pressure plate should be held downward as the clearance is checked.

   The clearance should be:

   4.9L (300 CID) EFI and

   5.0L (302 CID) EFI 1.02mm-1.91mm (0.040-0.075 in.)

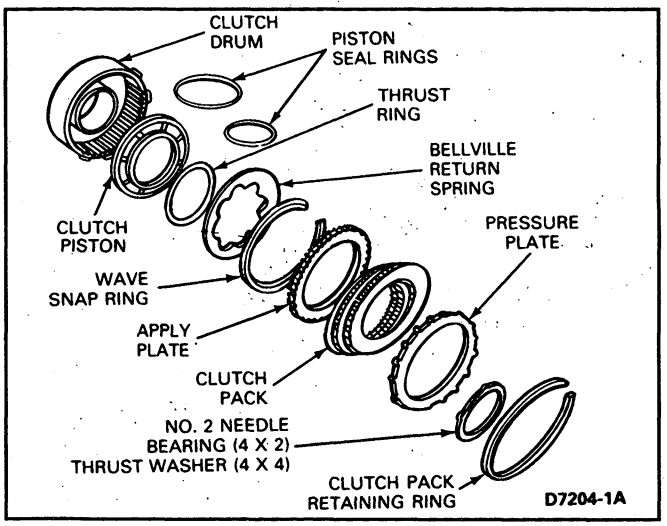


FIG. 45 Reverse Clutch—Exploded View

   If the clearance is not within specifications, selective snap rings are available in the following thicknesses: 0.060 to 0.064, 0.074 to 0.078, 0.088 to 0.092 and 0.102 to 0.106 inch. Insert the correct size snap ring and recheck the clearance.
7. Check the clutch for proper operation using air pressure. The clutch should be heard and felt to apply smoothly and without leakage.
8. Install the No. 2 needle bearing (4x2) or thrust washer (4x4).

Center Support and Planetary One-way Clutch

Refer to Fig. 48.

Disassembly

1. Remove the center support from the planetary carrier. Rotate the center support counterclockwise and lift to remove.
2. Carefully remove the planetary one-way clutch from the planetary assembly.

Assembly

1. If necessary, assemble the one-way clutch as shown in Fig. 49.

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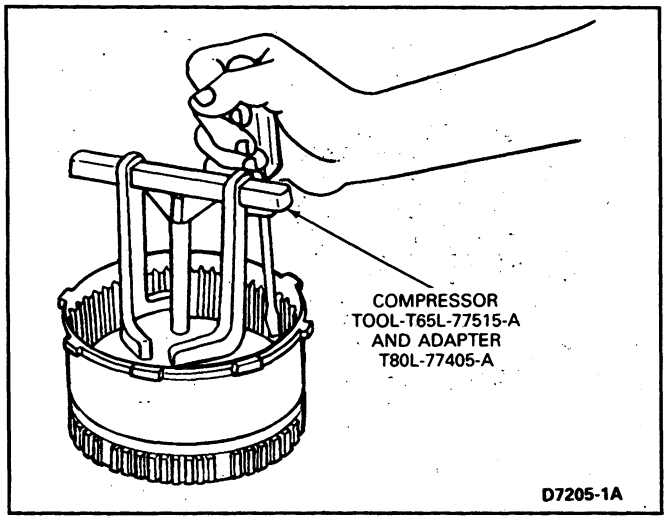


FIG. 46 Removing or Installing Wave Snap Ring

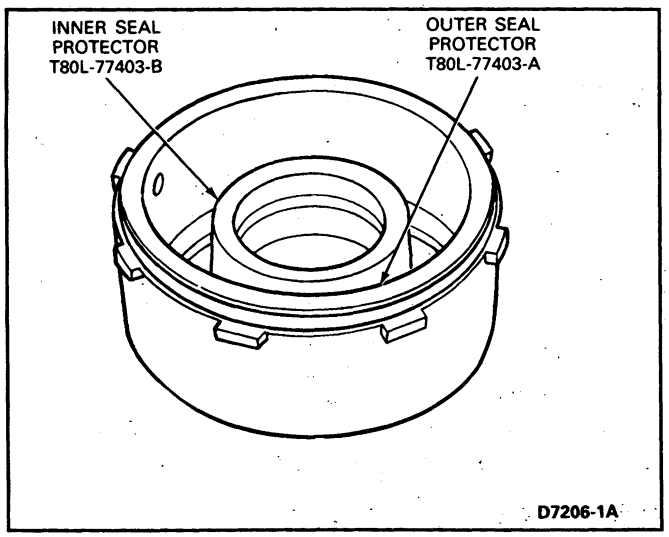


FIG. 47 Installing Clutch Piston

2. Install the one-way clutch in the planetary carrier.
3. Install the center support into the one-way clutch by rotating the center support counterclockwise.

   Lubricating the clutch races and the clutch assembly with petroleum jelly may aid in assembly.

Sun Gear and Drive Shell

Refer to Fig. 50.

Disassembly

1. Remove the No. 4 needle bearing from the drive shell.
2. Remove the forward sun gear and No. 5 needle bearing from the drive shell.
3. Remove the No. 5 needle bearing from the forward sun gear.

Assembly

The sun gear and drive shell will be assembled as part of the transmission assembly procedure.

Pump and Intermediate Clutch Piston

Refer to Fig. 51.

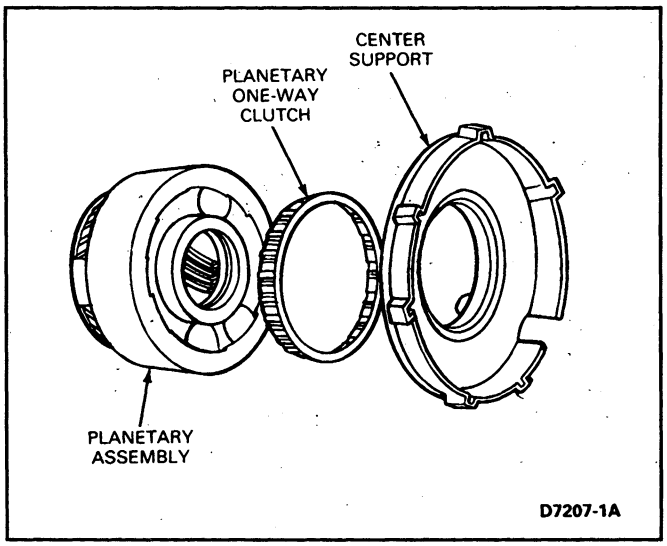


FIG. 48 Center Support and Planetary One-Way Clutch—Exploded View

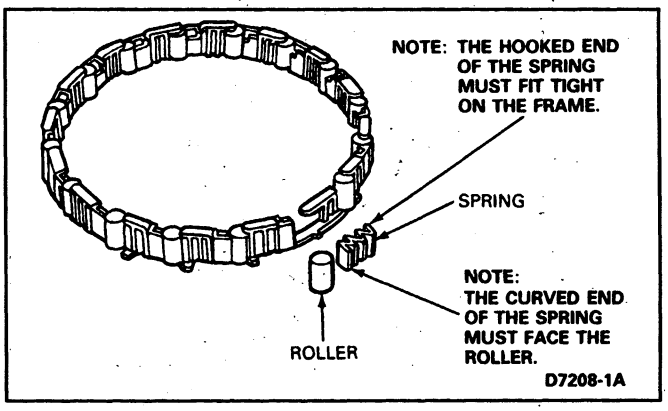


FIG. 49 One-Way Clutch Assembly

Disassembly

1. Remove the No. 1 thrust washer (Figs. 15 and 16).
2. Remove the four pump seal rings (Figs. 15 and 16). The reverse clutch rings are larger than the forward clutch rings.
3. Remove the pump body-to-case seal and discard.
4. Remove the spring retainer assembly by carefully dislodging the tabs (Fig. 52).
5. Remove the intermediate clutch piston.
6. Remove the five stator support bolts (10mm) and the stator support.
7. Remove the drive and driven pump gears from the pump body.

Assembly

1. Install the drive and driven pump gears in the pump body as shown in Fig. 53. Chamfers on both gears face into the pump body.
2. Position the stator support and install the bolts. Tighten bolts to 16-22 N·m (12-16 ft-lbs).
3. Install a new pump to case seal.
4. Install new seals on the clutch piston. Note the direction of the sealing lip before installation. The lips point away from the spring posts (Fig. 54).

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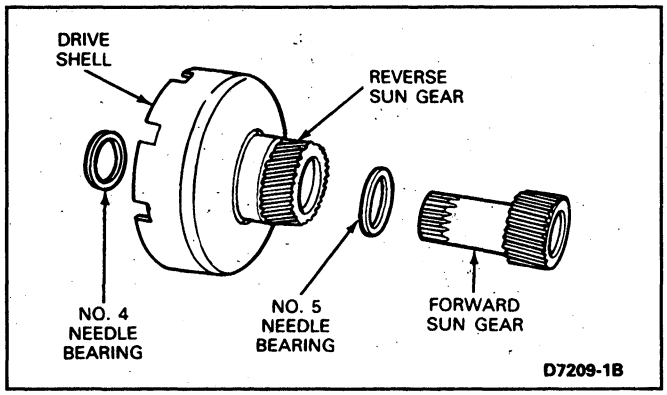


FIG. 50 Sun Gear and Drive Shell—Exploded View

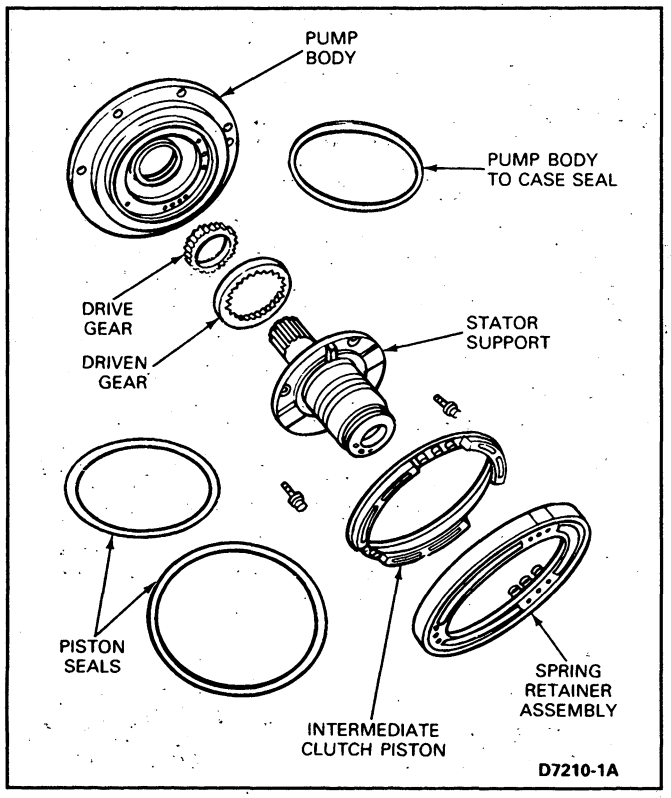


FIG. 51 Pump and Intermediate Clutch Piston—Exploded View

5. Install the clutch piston as follows:

   a. Coat the piston seals and the pump body sealing area with petroleum jelly.

   b. Install the piston in Seal Protector T80L-77005-A (or equivalent).

   c. Install the piston in the pump body and push to the bottom of the bore by exerting even thumb pressure on the piston.

   IMPORTANT NOTE: The piston bleed hole must be located at 12:00 position (toward top of transmission).

6. Snap the spring retainer assembly into place on the pump body. Use even pressure.

7. Install the pump seal rings.

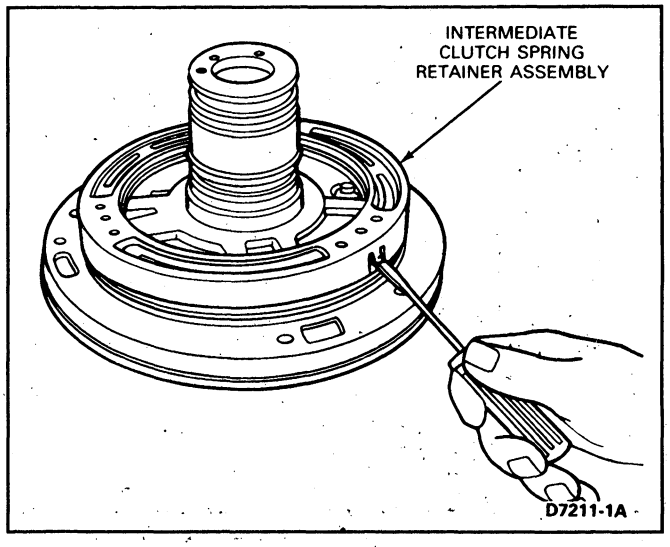


FIG. 52 Removing Spring Retainer

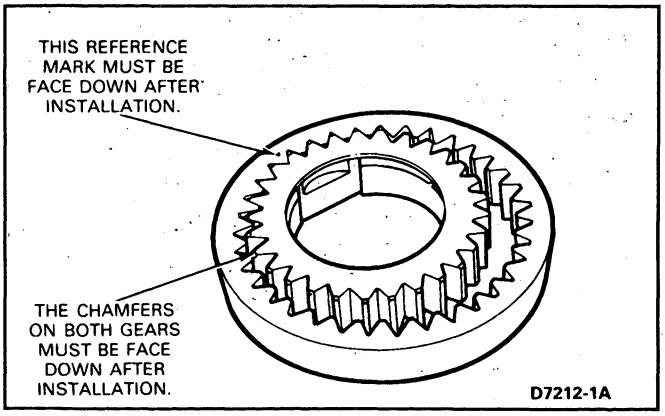


FIG. 53 Drive and Driven Pump Gear—Installation

Accumulators and Servos

Disassembly and Assembly

2-3 Accumulator

Refer to Fig. 55.

Install new seals on the accumulator piston. Be sure the diagonal cuts are properly aligned.

Low-Reverse Servo

Refer to Fig. 56.

Inspect the sealing edge on both the servo cover and the apply piston. Replace the cover or piston, if necessary.

Overdrive Servo

Refer to Fig. 57.

1. Pull the overdrive servo piston out of the piston cover.
2. Install new seals on the piston and cover.
3. Install the piston in the cover.

Valve Body

Refer to Figs. 58-69.

Disassembly

1. Remove and discard valve body gasket. Loosen and remove (11) bolts (10mm socket) from

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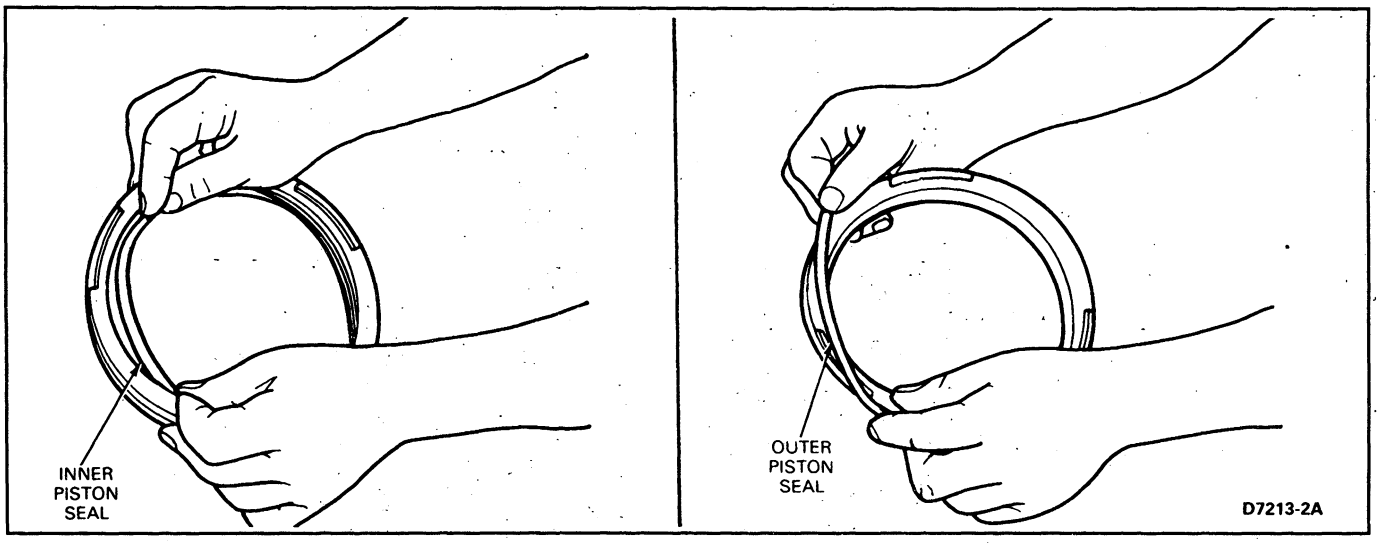


FIG. 54 Piston Seal Installation

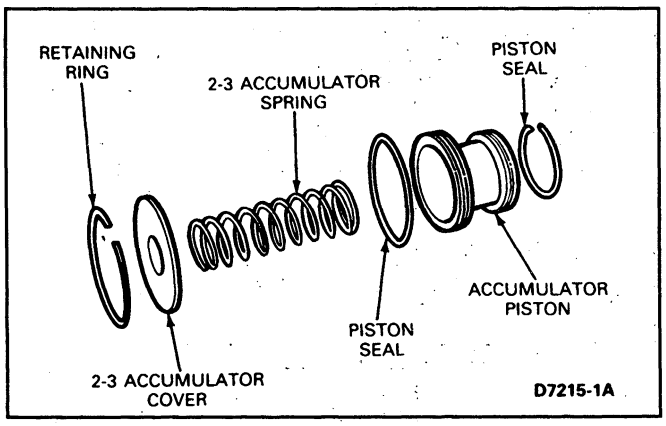


FIG. 55 2-3 Accumulator

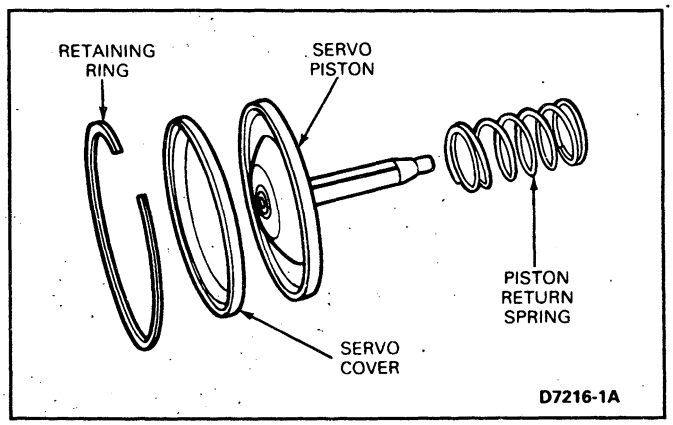


FIG. 56 Low-Reverse Servo—Exploded View

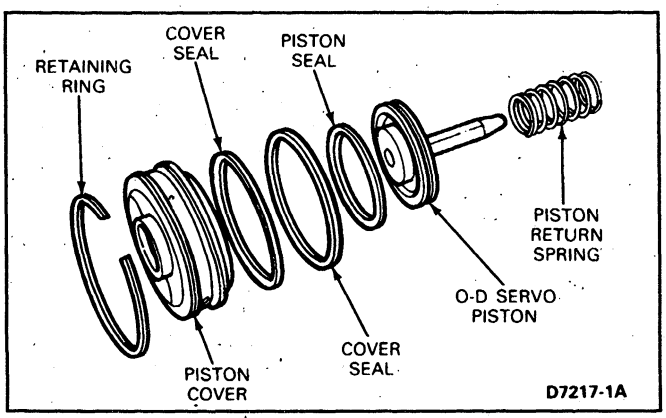


FIG. 57 Overdrive Servo—Exploded View

reinforcement plates and detent spring guide bolt (8mm) from separator plate (Fig. 59). Remove separator plate, reinforcement plates and separator plate gasket (Fig. 60). Discard gasket.

2. Remove the two relief valves and seven check balls from the valve body. Note the location of the orange ball. It is not interchangeable with the (6) black balls (Fig. 61).

3. Refer to Figs. 62-66 for identification and location of all valves in the valve body. Figs. 62-65 shows all valves in an exploded view. Fig. 66 shows all valve components assembled in the correct location in the valve body.

   NOTE: Most main control valve body plugs have tapped holes on the outside to accomodate a metric (M4) screw for easier removal of the plugs when cleaning or servicing the valve body. Reinstall the plugs with the tapped holes on the outside.

4. Remove the manual valve from the valve body.

5. With an awl or ice-pick, lift the retaining clip off the throttle sleeve. Press the throttle plunger into the bore and spring pressure will force the throttle sleeve out of the valve body. Position a finger to prevent the valves from flying out of the bore. Remove the throttle sleeve, preload spring, throttle plug, throttle control valve, throttle control spring and throttle plunger.

   NOTE: The chamfered stem of the throttle control valve faces the throttle plunger. The notch in the throttle plug faces the bottom of the sleeve bore.

6. Lift the retaining clip off the 2-3 backout valve with an awl or ice-pick. Remove the bore plug, spring and 2-3 backout valve.

7. Remove the retaining plate from the bore plug of the orifice control valve. Remove the bore plug,

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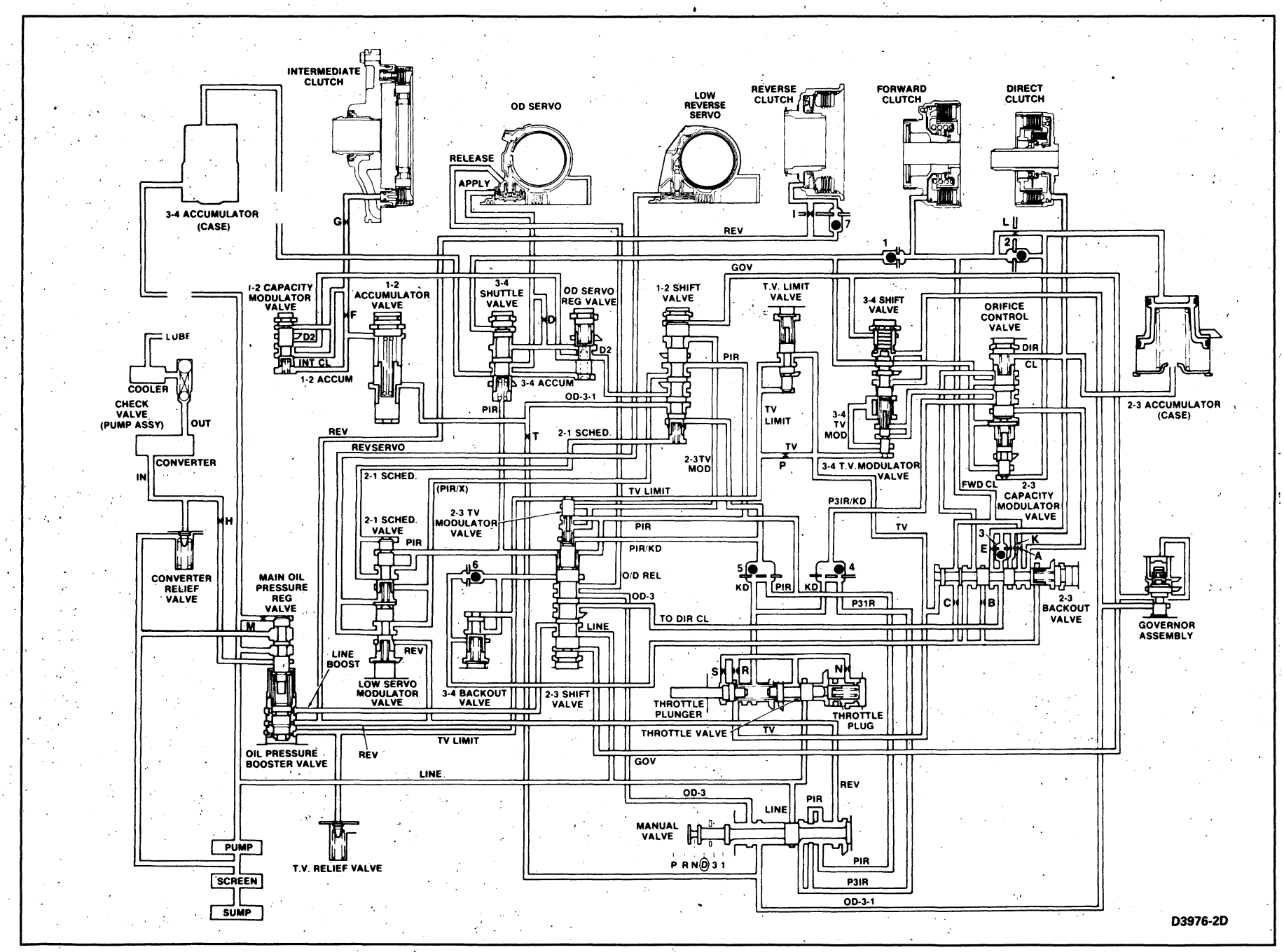


FIG. 58 Valve Body Schematic

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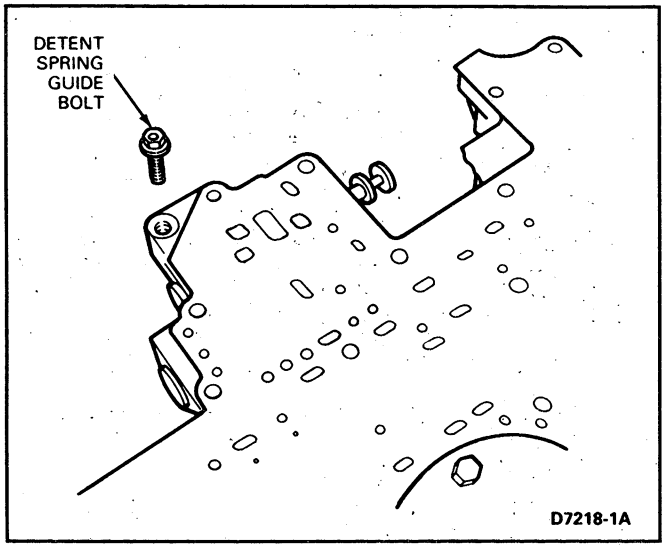


FIG. 59 Removing Detent Spring Guide Bolt

orifice control valve and spring. With needle-nose pliers, remove the spring retaining plate that separates the orifice control valve from the 2-3 capacity modulator valve. This retainer plate is longer and thicker than the other four spring retainer plates and must be reinstalled in this slot. Remove the modulator valve spring and 2-3 capacity modulator valve.

8. Lift the retaining clip off the 3-4 shift valve sleeve. Remove the sleeve, plug, 3-4 shift valve, spring, modulator valve spring and 3-4 TV modulator valve.

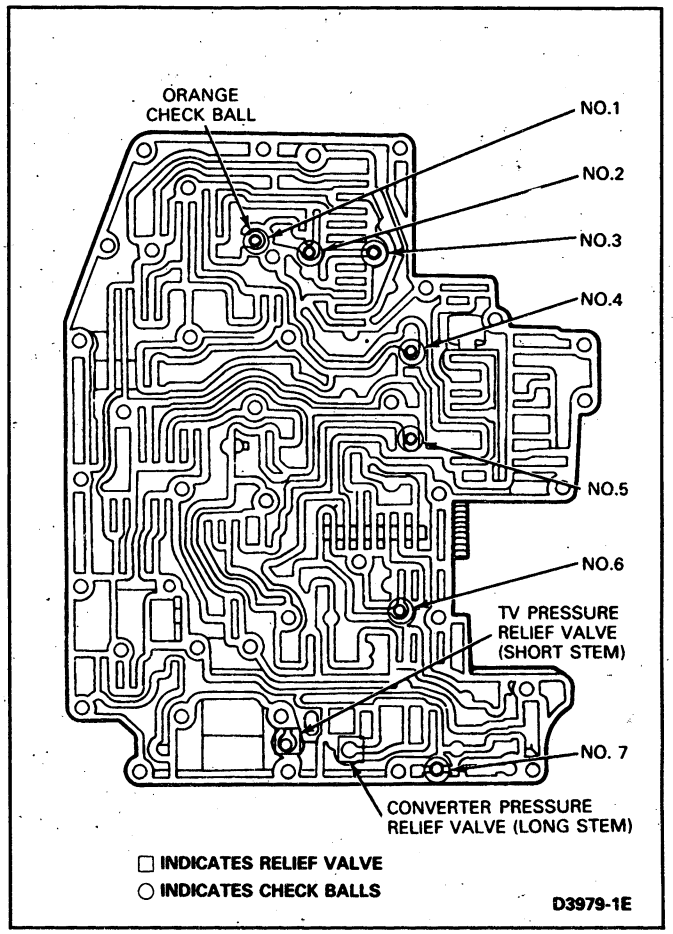


FIG. 61 Relief Valve and Check Ball Location

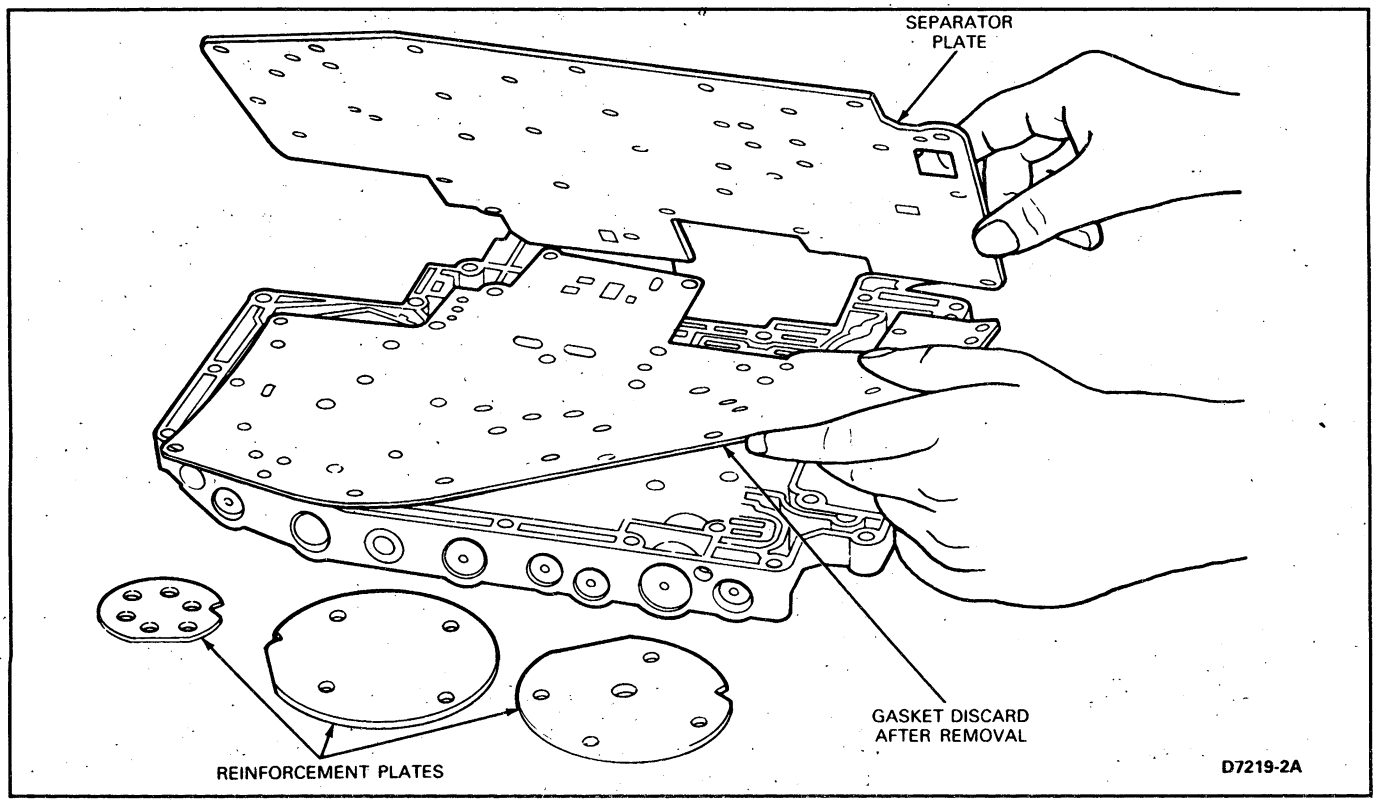


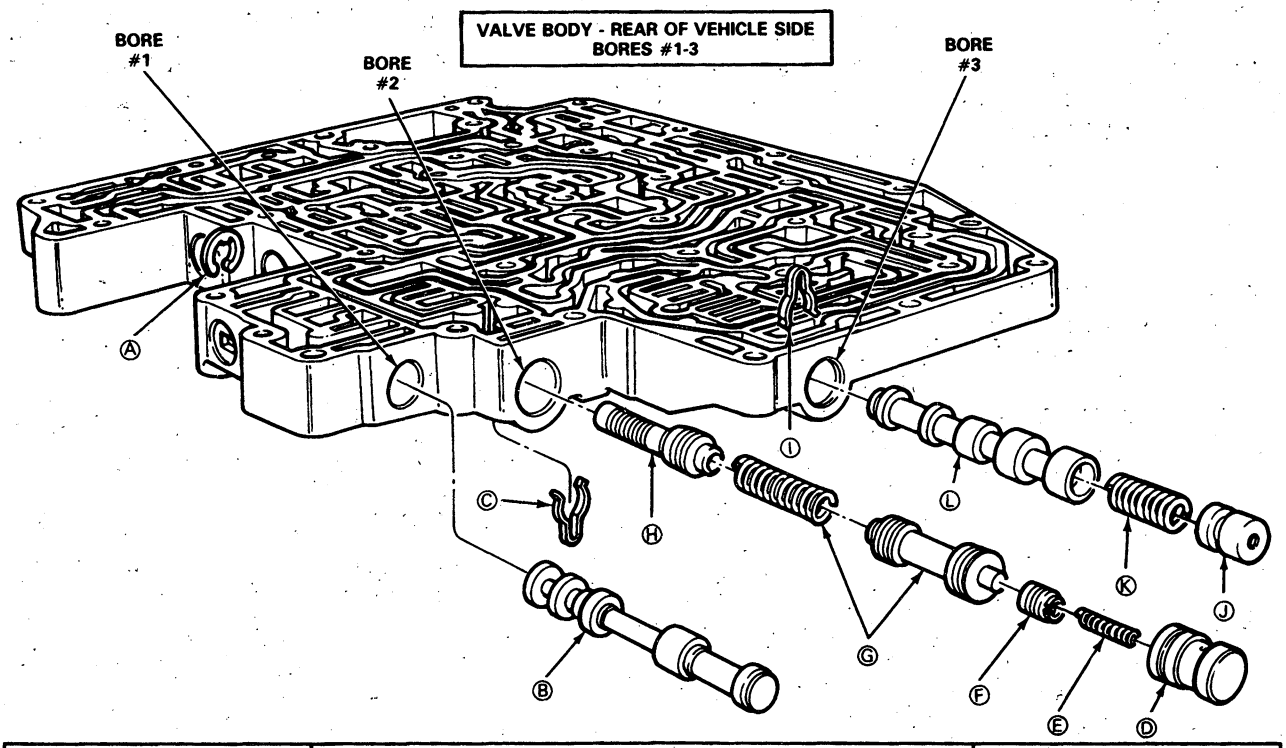
FIG. 60 Removing Separator Plate

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NOTE: The notch in the plug faces the bottom of the sleeve bore.

9. With needle-nose pliers, remove the spring retaining plate from the TV limit valve bore. Remove the spring and TV limit valve.
10. Remove the retaining clip from the 1-2 shift valve bore plug. Remove the bore plug, 1-2 shift valve and spring.
11. Remove plug retaining plate from the O.D. servo regulator valve bore plug. Remove the bore plug, spring and O.D. servo regulator valve.
12. Lift the retaining plate off the 3-4 shuttle valve bore plug. Remove the bore plug, 3-4 shuttle valve and spring.
13. With an awl or icepick, lift the retaining clip off the 1-2 accumulator valve bore plug. Remove the bore plug, O-ring seal, spring and 1-2 accumulator valve.

    NOTE: The 1-2 accumulator valve and valve body diameter are not the same for all models.
14. Remove the retaining clip from the 1-2 capacity modulator valve bore plug. Remove the bore plug, 1-2 capacity modulator valve and spring.
15. Remove the retaining clip from the boost sleeve. Remove the boost sleeve, boost valve, main regulator valve spring, boost valve spring, spring seat and main pressure regulator valve.
16. Two spring retainer plates hold and separate the 2-1 scheduling valve and the low servo modulator valve. Remove the outer spring retainer plate and low servo modulator spring and valve from the valve body. Remove the scheduling valve spring and the 2-1 scheduling valve.
17. With needle-nose pliers, remove the spring retainer plate from the 3-4 backout valve bore. Remove the spring and 3-4 backout valve.
18. Remove the retaining clip from the 2-3 shift valve bore plug. Remove the bore plug, 2-3 shift valve, the 3-2 control valve, the shift valve spring,



Bore #1	Bore #2	Bore #3
Ⓐ Clip	Ⓒ Clip	Ⓘ Clip
Ⓑ Manual Valve	Ⓓ Throttle Sleeve	Ⓙ Bore Plug
	Ⓔ Preload Spring	Ⓚ Spring
	Ⓕ Throttle Plug ①	Ⓛ 2-3 Backout Valve
	Ⓖ Throttle Control Valve and Spring ②	
	Ⓗ Throttle Plunger	

NOTES:

All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

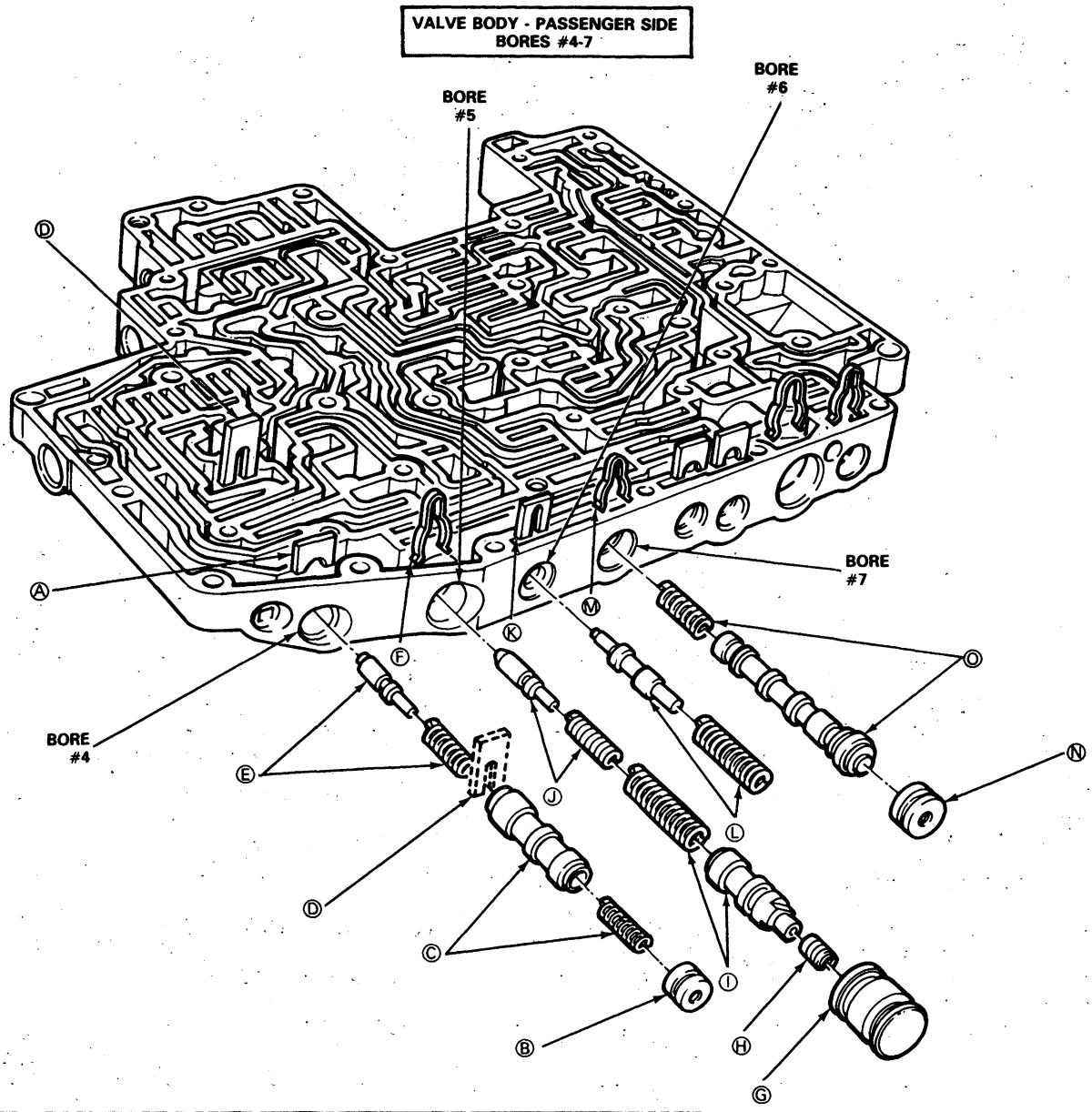
① The notch in the throttle plug faces the bottom of the throttle sleeve bore.

② The chamfered stem of the throttle control valve faces the throttle plunger.

D6280-2B

FIG. 62 Valve Body—Exploded View—Bores #1-3

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Bore #4	Bore #5	Bore #6	Bore #7
Ⓐ Spring Retainer Plate	Ⓕ Clip	Ⓚ Retainer Plate	Ⓜ Clip
Ⓑ Bore Plug	Ⓖ Sleeve	Ⓛ TV Limit Valve and Spring	Ⓝ Bore Plug
Ⓒ Orifice Control Valve and Spring	Ⓗ Plug ②		Ⓞ 1-2 Shift Valve and Spring
Ⓓ Spring Retainer Plate ①	Ⓘ 3-4 Shift Valve and Spring		
Ⓔ 2-3 Capacity Modulator Valve and Spring	Ⓙ 3-4 TV Modulator Valve and Spring		

NOTES:

All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

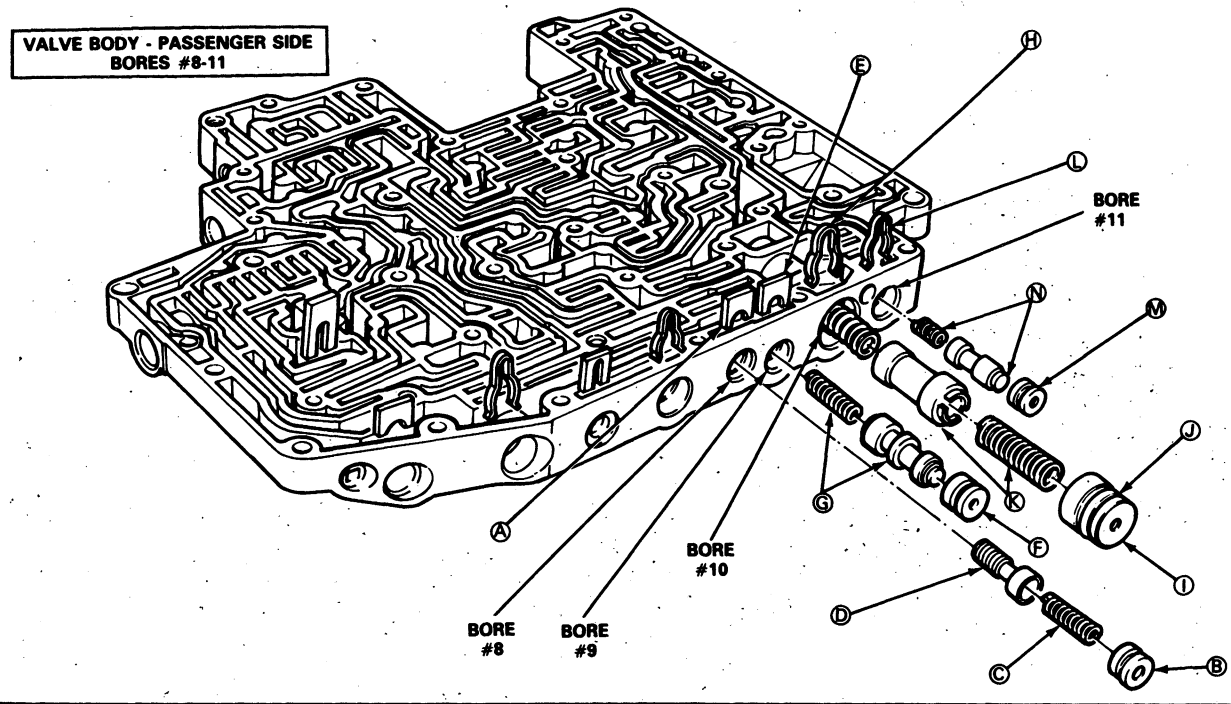
① The 2-3 Capacity Modulator Valve Retainer Plate is thicker and longer than the other plates. It must be installed in this slot.

② The notch in the 3-4 plug faces the bottom of the sleeve bore.

D6281-2B

FIG. 63 Valve Body—Exploded View—Bores #4-7

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Bore #8	Bore #9	Bore #10	Bore #11
(A) Spring Retainer Plate	(E) Retainer Plate	(H) Clip	(L) Clip
(B) Bore Plug	(F) Bore Plug	(I) Bore Plug	(M) Bore Plug
(C) Spring	(G) 3-4 Shuttle Valve and Spring	(J) O-ring Seal (1)	(N) 1-2 Capacity Modulator Valve and Spring
(D) O.D. Servo Regulator Valve		(K) 1-2 Accumulator Valve and Springs (2)	

NOTES:

All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

① When installing the 1-2 Accumulator Valve Bore Plug into the bore, the O-ring seal must face towards the outside of the valve body.

② The 1-2 Accumulator Valve and valve body diameter are not the same for all models.

D6282-2C

FIG. 64 Valve Body—Exploded View—Bores #8-11

modulator valve spring, and 2-3 TV modulator valve.

19. Inspect and clean the valve body as described in Section 17-01, General Automatic Transmission Service, under Control Valve Body—Cleaning and Inspection.

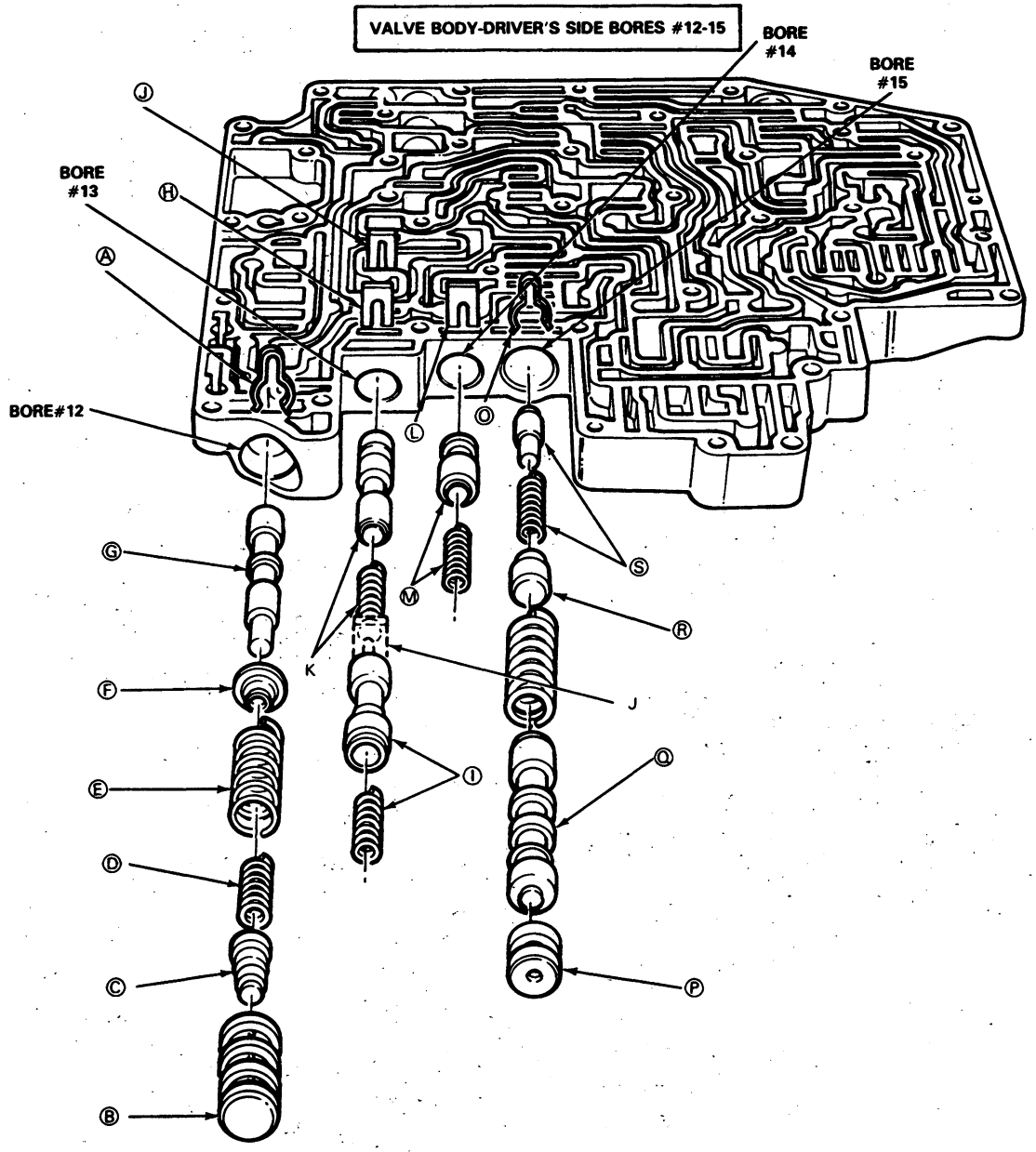
Assembly

Before installing the control valves, lubricate the bores, valves, springs and seals with clean transmission fluid.

Refer to Figs. 62-65 for correct assembly of all valve components. Refer to Fig. 66 for correct location of the valves in the body.

1. Insert the 2-3 TV modulator valve, modulator valve spring, the 3-2 control valve, shift valve spring, and 2-3 shift valve in the valve body. Insert the bore plug and from the underside of the body place the retaining clip in the slot on the bore plug.
2. Install the 3-4 backout valve and spring in the valve body. Insert the spring retainer plate in the proper slot in the valve body.
3. Place the 2-1 scheduling valve and spring in the valve body. Install the spring retainer plate in the bore. Install the low servo modulator valve and spring into the bore in front of the retainer plate that separates the scheduling valve from the modulator valve. Insert the retaining clip into the proper slot in the valve body.
4. Install the main pressure regulator valve, spring seat, boost valve spring, main regulator valve spring, boost valve and boost sleeve. Install the retaining clip on the boost sleeve.
5. Install spring, 1-2 capacity modulator valve, and bore plug in the valve body. Place retaining clip on bore plug.
6. Install the 1-2 accumulator valve, and spring. Install the O-ring in the shallow groove of the bore plug and lubricate the O-ring. Install the bore plug

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Bore #12	Bore #13	Bore #14	Bore #15
Ⓐ Clip	Ⓗ Spring Retainer Plate	Ⓛ Spring Retainer Plate	Ⓞ Clip
Ⓑ Boost Sleeve	Ⓘ Low Servo Modulator Valve and Spring	Ⓜ 3-4 Back Out Valve and Spring	Ⓟ Bore Plug
Ⓒ Boost Valve	Ⓙ Spring Retainer Plate		Ⓠ 2-3 Shift Valve and Spring
Ⓓ Boost Valve Spring	Ⓚ 2-1 Scheduling Valve and Spring		Ⓡ 3-2 Control Valve
Ⓔ Main Regulator Valve Spring			Ⓢ 2-3 TV Modulator Valve and Spring
Ⓕ Spring Seat			
Ⓖ Main Pressure Regulator Valve			

NOTES: All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

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FIG. 65 Valve Body—Exploded Views—Bores #12-15

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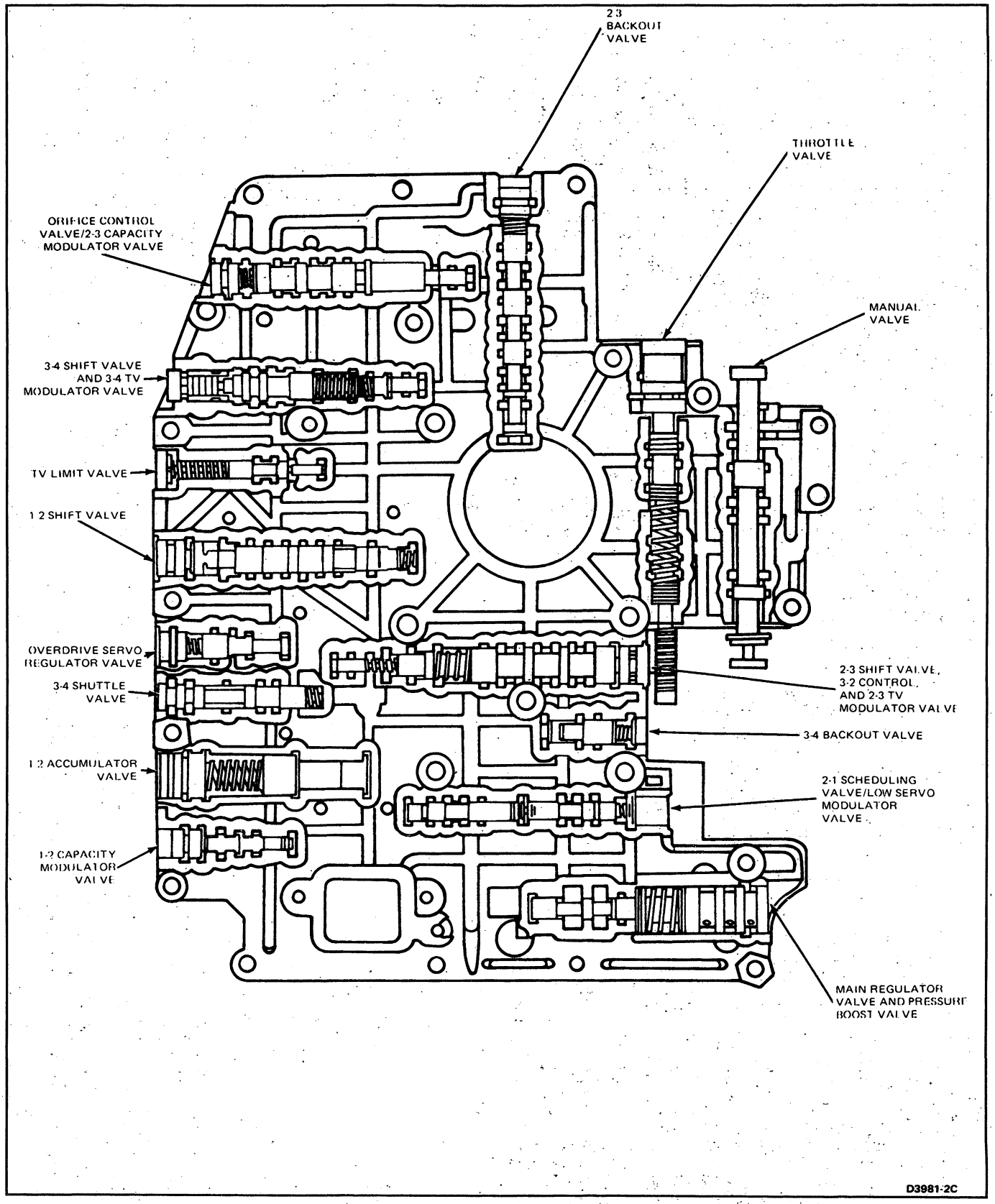


FIG. 66 Valve Locations

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into the bore with the O-ring toward the outside. Install the retaining clip on the bore plug.

NOTE: The 1-2 accumulator valve and valve body diameters are not the same for all models.

7. Insert the spring, 3-4 shuttle valve, and bore plug in the valve body. Place retaining plate on bore plug.
8. Install the O.D. servo regulator valve, spring and bore plug into bore. Install the bore plug by turning the plate into the slot of the bore plug.
9. Place spring, 1-2 shift valve, and bore plug into valve body. Install retaining clip on bore plug.
10. Insert TV limit valve and spring into valve body bore. Insert spring retainer plate in slot of valve body bore.
11. Install 3-4 TV modulator valve and spring, 3-4 shift valve and spring, plug and sleeve in valve body. Place retaining clip on sleeve. NOTE: The notch in the plug faces the bottom of the sleeve bore.
12. Place 2-3 capacity modulator valve and spring in bore. Install the spring retainer plate that separates the 2-3 capacity modulator valve and orifice control valve.

    NOTE: The spring retainer plate is thicker and longer than the other four retainer plates. Insert orifice control valve and spring, and bore plug in front of retainer plate. Install retaining plate on bore plug.
13. Install 2-3 backout valve, spring and bore plug in valve body. Install retaining clip on bore plug.
14. Install throttle plunger, throttle control spring, and throttle control valve.

    NOTE: The chamfered stem of the throttle control valve faces the throttle plunger.
15. Assemble the preload spring and throttle plug into the throttle sleeve, then load this assembly into the bore. Hold the sleeve into the bore and install the retaining clip from the opposite (unfinished) side of the valve body. NOTE: The notch in the throttle plug faces the bottom of the sleeve bore.
16. Install the manual valve in the valve body bore.
17. Install the valve body check balls (Fig. 61).

    Note the location of the orange ball. This ball is larger than the others and is not interchangeable.
18. Install the pressure relief valves (Figs. 61 and 67).
19. Install Alignment Pins T80L-77100-A (Fig. 67). Note the location of the pins. These two holes are smaller than the other bolt holes to assure proper alignment of gasket and separator plate with valve body. These two holes also align the valve body gasket and valve body assembly with the case.
20. Use a new separator plate gasket. Slide the gasket and the separator plate over the two alignment pins. Position the (3) reinforcement plates and loosely install the (11) bolts (Fig. 69). Loosely install the detent spring guide bolt. (Fig. 68, This bolt is the same as the short valve body assembly to case attaching bolts).
21. Starting at the center (large) reinforcement plate and working outward, tighten the eleven 10mm bolts to specification (Fig. 69). Then tighten the 8mm detent spring guide bolt to specification. Remove the alignment pins.

Pump Bushing

Disassembly and Assembly

1. Remove the bushing using Bushing Remover T80L-77268-B or equivalent (Fig. 70).
2. Install the bushing using Bushing Installer T80L-77268-A or equivalent (Fig. 70).

Case Bushing

Disassembly and Assembly

To remove the transmission case bushing use Slide Hammer T50T-100-A and Seal Remover TOOL-1175-AC or equivalent (Fig. 71).

1. Position the replacement bushing on Bushing Installer T80L-77110-A or equivalent (Fig. 74) and install in the bushing bore through the front of the case.
2. Thread Slide Hammer T50T-100-A or equivalent into the bushing installer through the back of the case and install the bushing.

Transmission

Refer to Figs. 15, 16 and 17.

Assembly

1. Install the No. 9 output shaft needle bearing in the transmission case.
2. Install the bearing support, No. 7 needle bearing and direct clutch hub in the direct clutch.
3. Install the output shaft, the ring gear and the direct clutch as an assembly. This assembly must be assembled as follows:
   a. Assemble output shaft hub to output shaft with retaining ring (seal rings already installed).
   b. Put No. 8 needle bearing in place on rear of direct clutch cylinder.
   c. Slide output shaft into direct clutch cylinder.
   d. Attach output shaft hub to ring gear with retaining ring.
4. Install the governor drive ball, the governor assembly and the governor retaining ring.

   Make sure that the face of the governor body is about flush with the counterweight. The cover and attaching screws must face forward in the case.
5. Install the low-reverse band. Make sure the band is seated on the anchor pins (View A, Fig. 73).

   NOTE: When properly installed, the center of the band anchor can be seen through the servo piston bore (View B, Fig. 73).
6. Install the center support and planetary assembly. Rotate the output shaft, if necessary, to align the planet carrier splines with the direct clutch hub splines.

   NOTE: The planet carrier and center support assembly cannot be installed unless the notch cut in the center support is aligned with the overdrive band anchor pin (Fig. 74).
7. Install the center support anti-clunk spring using a hammer handle or wooden dowel in position shown in Fig. 75.
8. Install the center support retaining ring in position shown in Fig. 76.

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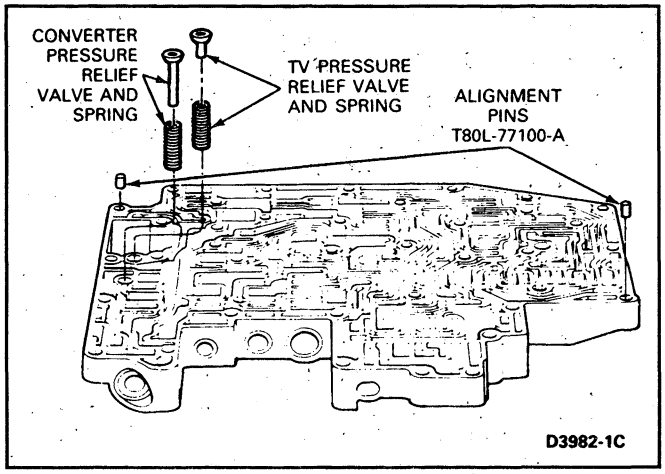


FIG. 67 Installing Pressure Relief Valves

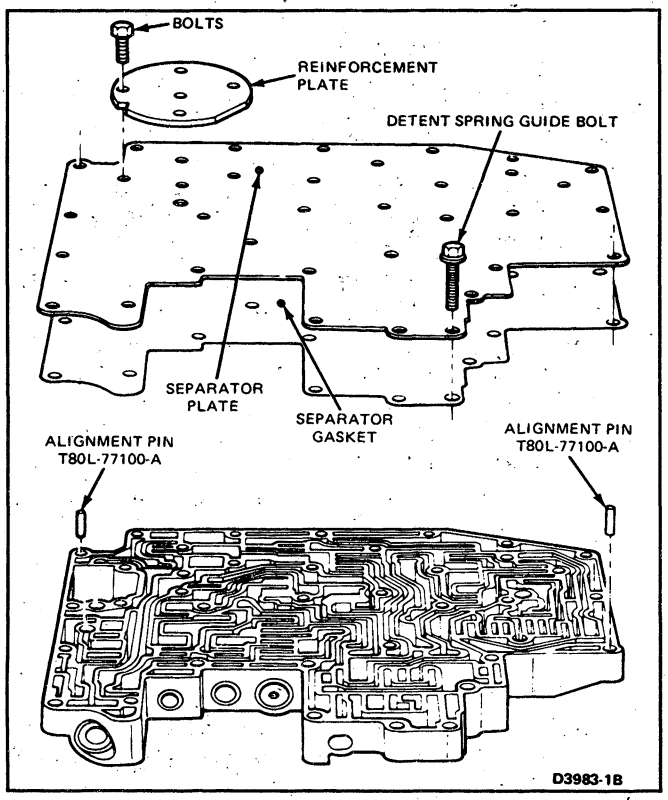


FIG. 68 Separator Plate Installation

9. To determine the correct length of the servo low-reverse pin proceed as follows:
   a. Install the low-reverse servo piston and return spring. Do not install the piston cover or retaining ring.
   b. Install servo selector Tool T80L-77030-A and tighten the band apply bolt on Tool T80L-77030-A to 5.6 N·m (50 in-lbs) (Fig. 77).
   c. Attach a dial indicator, TOOL-4201-C or equivalent and position the indicator stem on the flat portion of the piston, zero the dial indicator (Fig. 78).
   d. Thread the bolt out of the selector tool until the piston stops against the bottom of the tool.
   e. Read the amount of piston travel on the dial indicator.

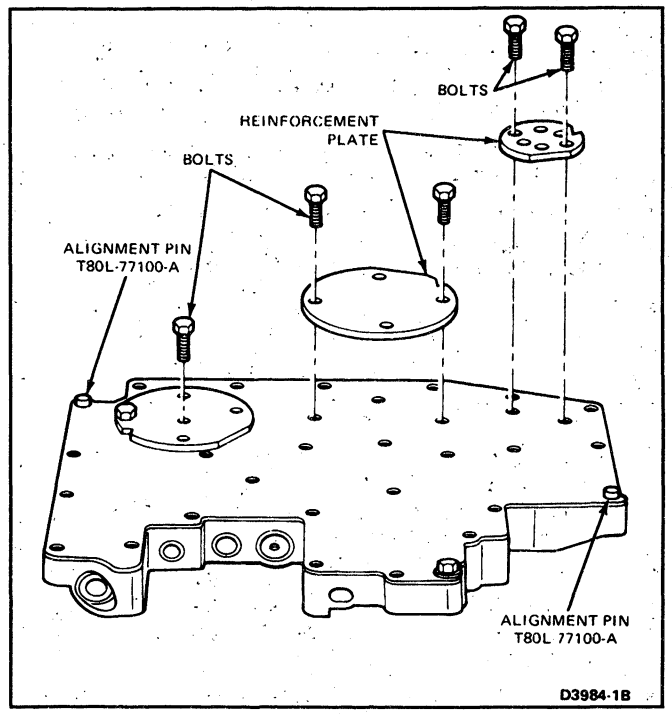


FIG. 69 Reinforcement Plate Installation

   - If the travel is 2.845-6.020mm (0.112-0.237 inch) the piston length is within specification.
   - If the travel is not within specification selective pistons are available in the following lengths:

     I.D.

     1. 2.936—1 groove
     2. 2.989—2 grooves
     3. 3.043—3 grooves

     Length of rod measured from piston surface to end of rod.

     Select the proper rod to bring the servo piston travel within specification.

   f. Remove the servo selection tool and dial indicator.
   g. Install the servo cover and retaining ring.
10. Install the reverse clutch on the forward clutch.

    NOTE: Make sure the No. 2 needle bearing (4x2) or No. 2 thrust washer (4x4) is in position.
11. Install the No. 3 needle bearing and forward clutch hub in the forward clutch.
12. Position the No. 4 needle bearing on the forward clutch hub and install the drive shell.
13. Install the No. 5 needle bearing and forward sun gear on the drive shell.
14. Install the drive shell, forward clutch and reverse clutch as an assembly. Rotate the output shaft, as necessary, to aid the engagement of the sun gear with the planetary gears.
15. Install the overdrive band. Make sure the band anchor is properly positioned on the anchor pin as shown in Fig. 79.
16. Install the overdrive servo and retaining snap ring (Fig. 80).

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17. With the overdrive servo installed, inspect the piston and band for proper position and engagement. If the band anchor and piston are not properly engaged as shown in Fig. 81, remove the servo and reposition the band as necessary.
18. Install the intermediate clutch pack components in the following order.
    1. The pressure plate
    2. The clutch pack
    3. The selective steel plate
19. Measure the intermediate clutch clearance using a depth micrometer and end-play checking Tool T80L-77003-A or equivalent (Fig. 82). Set the end-play tool across the pump case mounting. Locate the micrometer end-play bar and read depth. The depth at the intermediate clutch separator plate should be 41.5-41.8mm (1.634-1.646 inch) for the 4.9L (300 CID) EFI and 5.0L (302 CID) EFI applications. Check depth again 180 degrees opposite and assure the average depth is within tolerance.

    NOTE: Maintain a downward pressure on the clutch pack while measuring depth.

    If the depth is not within tolerance, the following size selective steel separator plates are available:

    0.071 inch—0.067 inch

    0.081 inch—0.077 inch

    0.091 inch—0.087 inch

    0.101 inch—0.097 inch

    Install the correct plate and recheck the clearance.
20. Check transmission end-play by locating the depth micrometer on end-play Bar T80L-77003-A (or equivalent) so that depth is measured at the reverse clutch drum thrust face (Fig. 83). Check end-play 180 degrees opposite to determine average depth. The following chart shows the proper selective thrust washer for various depth measurements (Fig. 84).
21. Install the selective washer determined in Step 20 on the Pump as shown in Fig. 85. Use petroleum jelly to hold it in place.
22. Install a pump alignment dowel. The alignment dowel can be fabricated by removing the head from a M8-1.25 bolt. Install the dowel only a few threads in the position shown in Fig. 86.
23. Install a new pump gasket, and "O" ring.
24. Using Slide Hammers T59L-100-B and metric Adaptors T80L-77103-A (or equivalent), lower the pump assembly into the case to the position shown in Fig. 87.
25. Remove the alignment dowel and install the seven pump attaching bolts. Alternately tighten the bolts a few turns at a time to draw the pump into the case. Tighten the attaching bolts to the specified torque.
26. Assemble 3-4 accumulator. Install the piston (and spring, if so equipped). Lubricate the rubber seal on the cover and the top of the bore to help cover installation. Install the cover.

    IMPORTANT NOTE: After assembly, the cover must be fully up and seated against retaining ring to avoid exposing a pressure passage. Use air pressure if necessary to seat cover up against retaining ring.
27. Assemble the 2-3 accumulator.
28. Install valve body alignment Pins T80L-77100-A (or equivalent) in the positions shown (Fig. 88).
29. Install the valve body gasket and the valve body assembly over the pins.

    NOTE: Make sure the manual and throttle levers are properly positioned before installing the valve body attaching bolts.
30. Loosely install (25) valve body attaching bolts. Starting at the center and working outward, tighten the bolts to specification (8mm socket) (Fig. 89, View A).

    NOTE: Two different length bolts are used. The shorter bolts are used at the four front, one center and three rear locations. (Fig. 89, View B).
31. Remove the alignment pins and install bolts (short). Install the detent spring and roller assembly (long bolt). Tighten the bolts to 9-11 N·m (80-100 in-lbs) torque.
32. Position the TV lever torsion spring against the separator plate V notch (Fig. 90). This spring pushes the throttle lever in the direction of wide open throttle.
33. Install the filter grommet, a new filter gasket and the filter on the valve body.

    NOTE: If the fluid was contaminated be sure to use a new filter. Never attempt to clean or reuse a dirty filter.
34. Install the filter attaching bolts (8mm) and tighten to 9-14 N·m (80-120 in-lb) torque.
35. Position a new pan gasket and install the oil pan (10mm socket). Tighten the attaching bolts to the specified torque.
36. Clean the mounting surface on the transmission and on the extension housing. Remove any sealant from the bolts and the case bolt holes. Position a new gasket on the transmission. Coat the bolts with Ford Threadlock and Sealer E0AZ-19544-AA (ESE-M4G204-A, Type II) or Ford Pipe Sealant with Teflon®, D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) housing bolts and tighten to 22-27 N·m (16-20 ft-lb).
37. Install the direct driveshaft.
38. Install the torque converter. Make sure the converter is fully seated in the pump.

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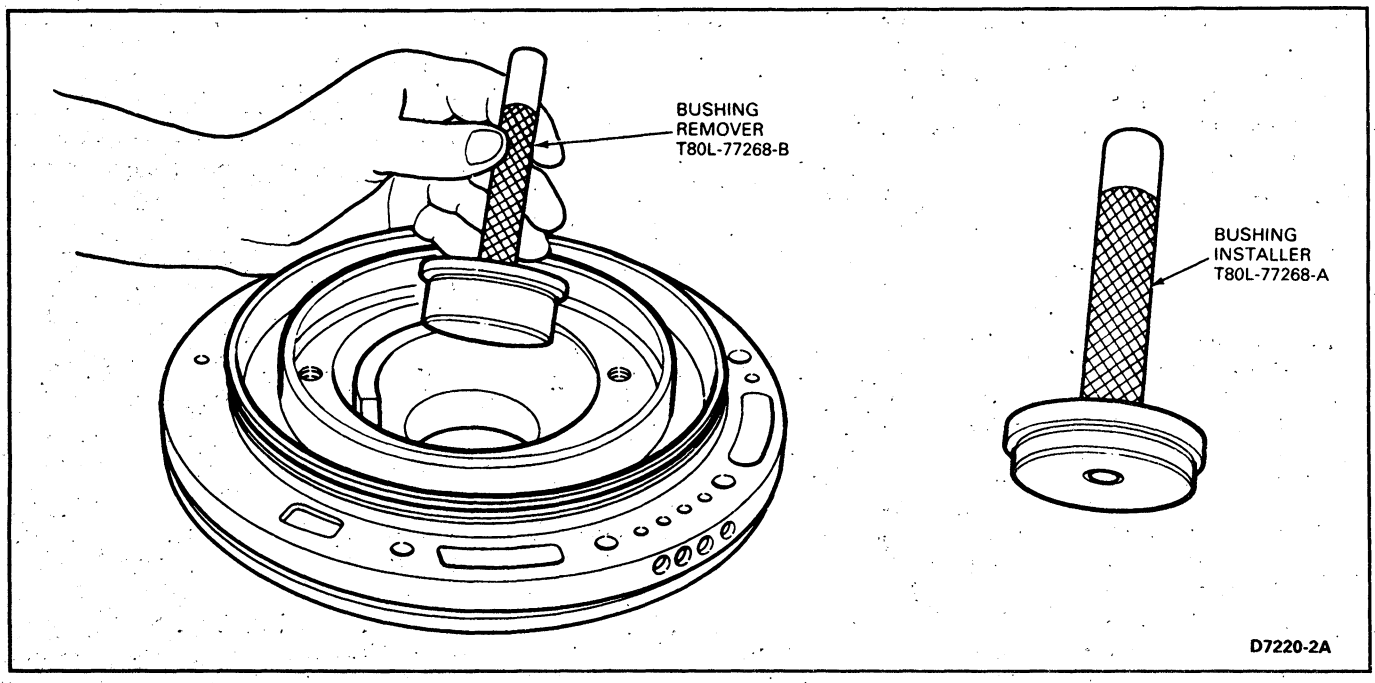


FIG. 70 Pump Bushing Removal and Installation

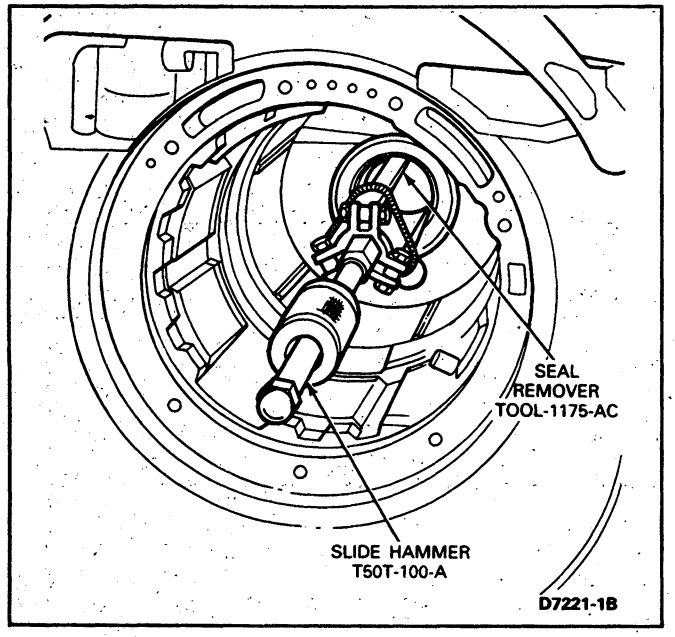


FIG. 71 Case Bushing Removal

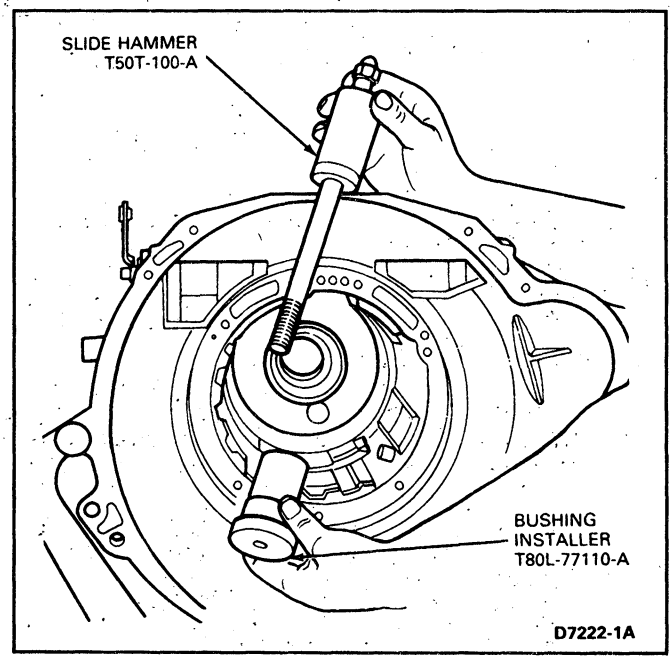


FIG. 72 Case Bushing Installation

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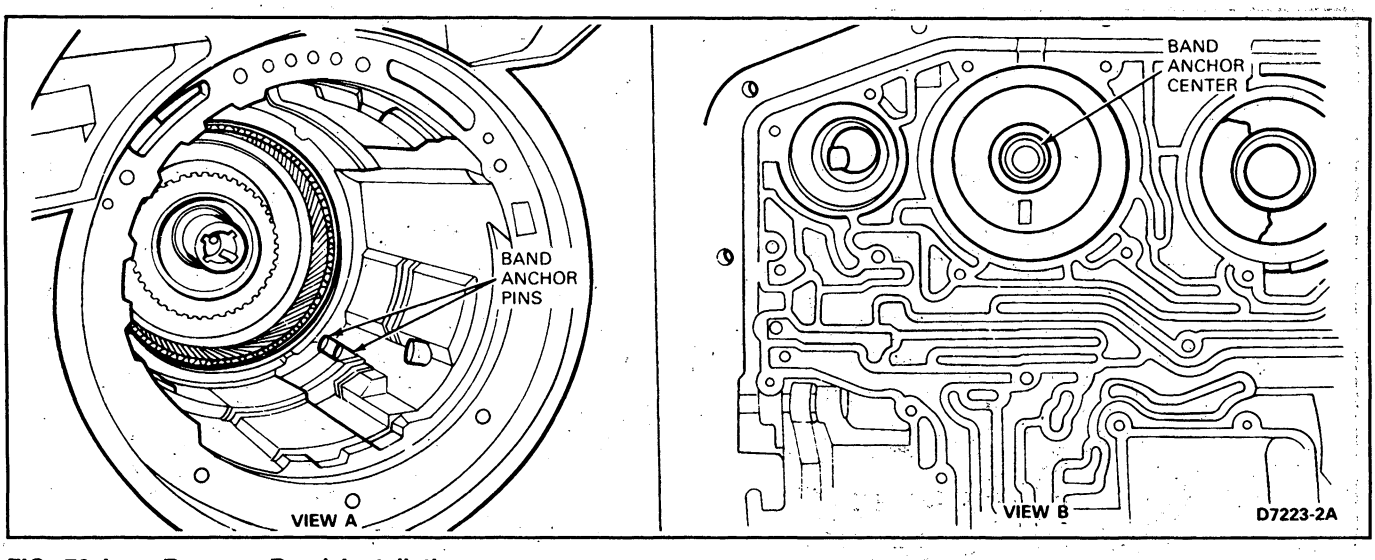


FIG. 73 Low Reverse Band Installation

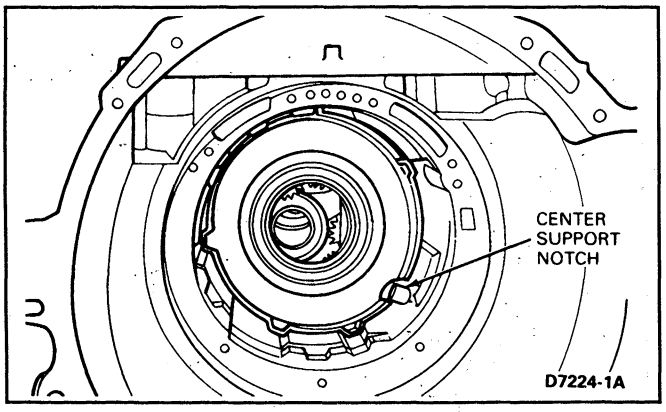


FIG. 74 Center Support and Planetary Assembly

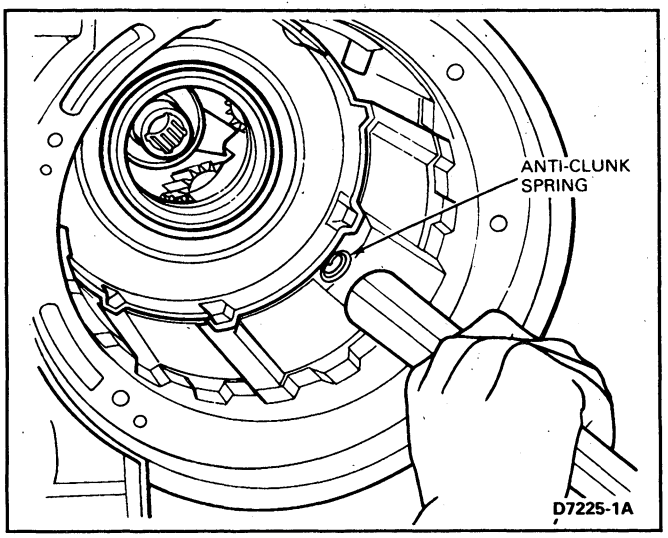


FIG. 75 Installing Anti-Clunk Spring

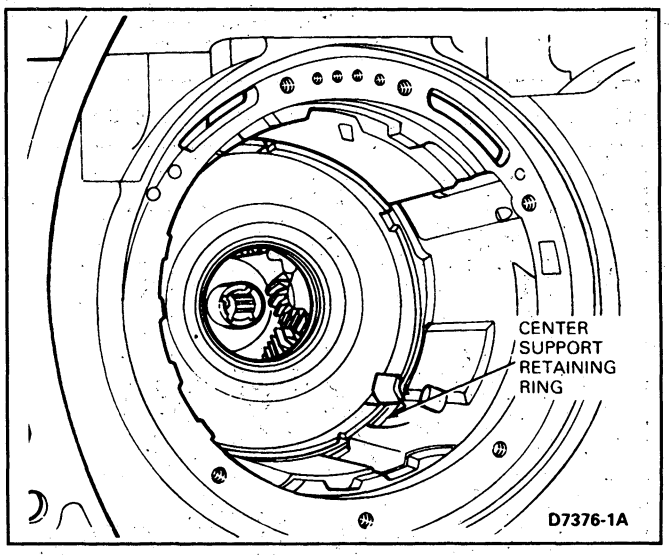


FIG. 76 Installing Center Support Retaining Ring

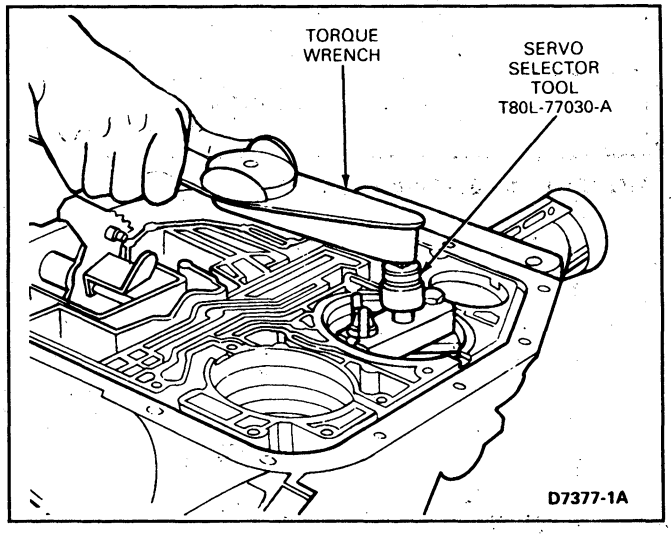


FIG. 77 Installing Servo Selector Tool

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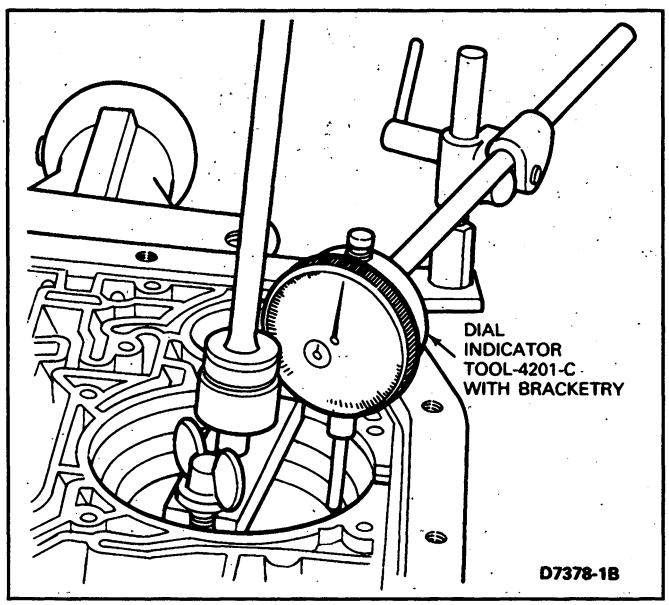


FIG. 78 Checking Pin Length

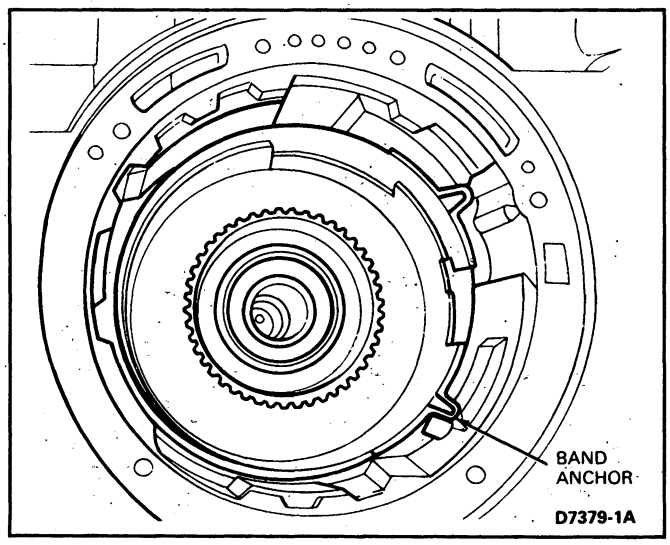


FIG. 79 Overdrive Band Installation

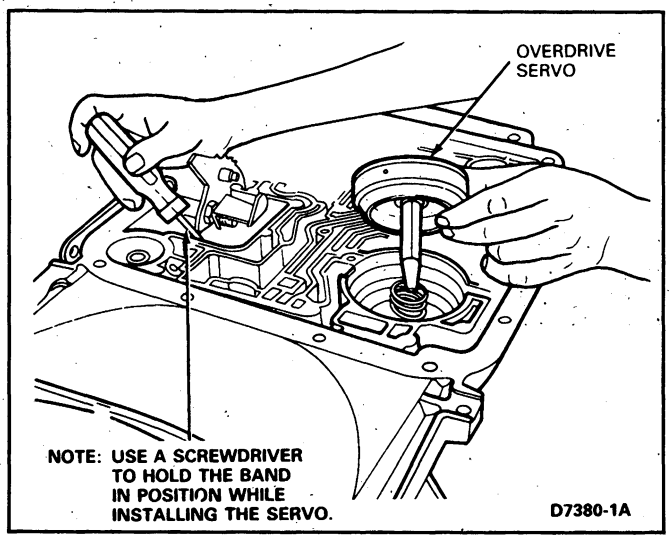


FIG. 80 Installing Overdrive Servo

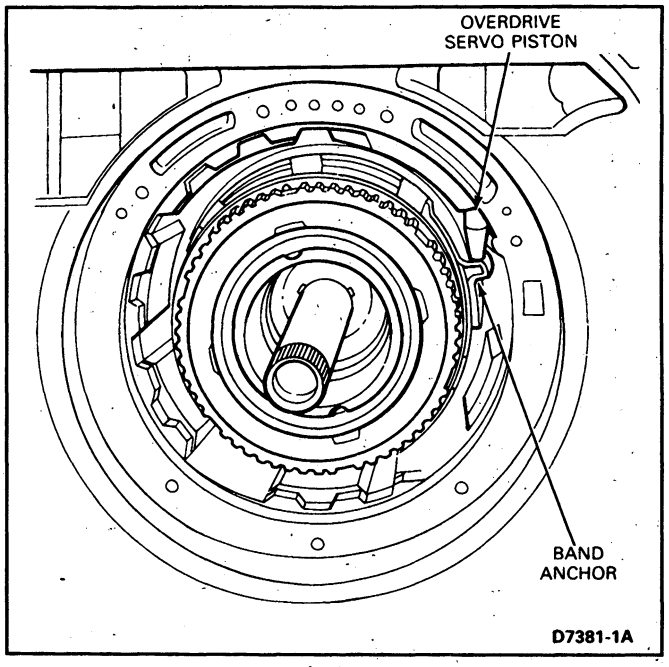


FIG. 81 Overdrive Servo Piston Engagement

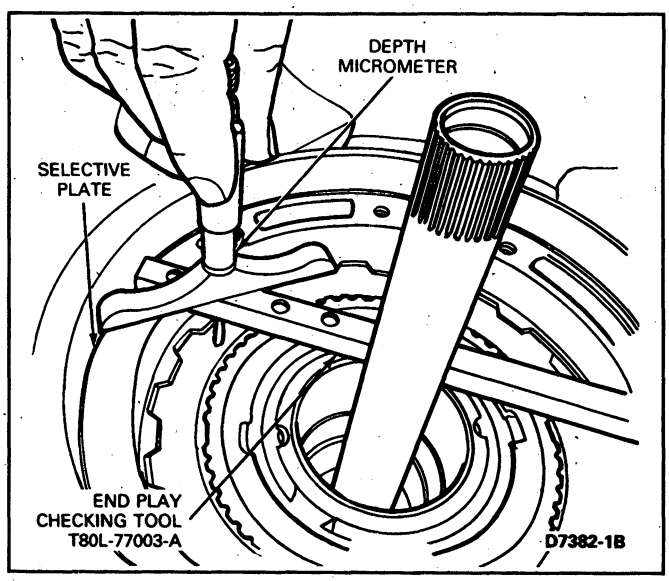


FIG. 82 Measuring Intermediate Clutch Clearance

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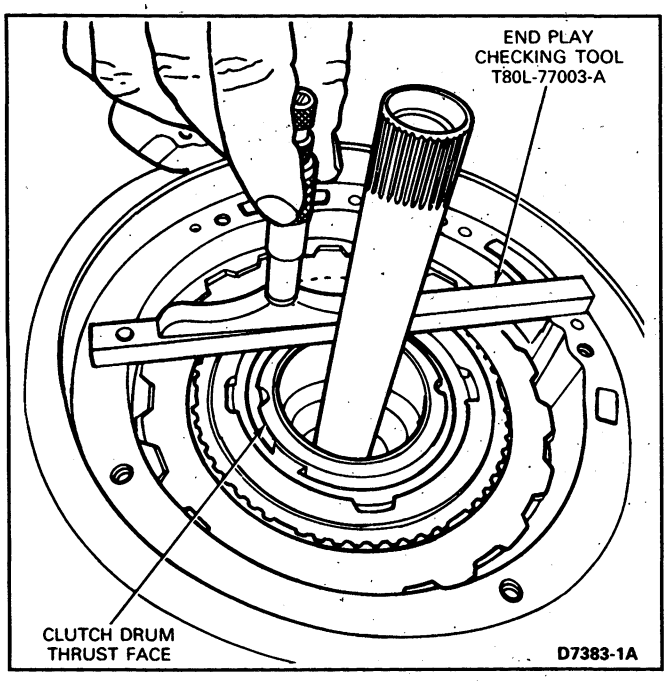


FIG. 83 Checking Transmission End Play

Depth	Washer No.	Washer Size	Washer Color
1.483"-1.500"	1	0.050"-0.054"	Green
1.501"-1.517"	2	0.068"-0.072"	Yellow
1.518"-1.534"	3	0.085"-0.089"	Natural
1.535"-1.551"	4	0.102"-0.106"	Red
1.552"-1.568"	5	0.119"-0.123"	Blue

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FIG. 84 Selective Thrust Washer Usage

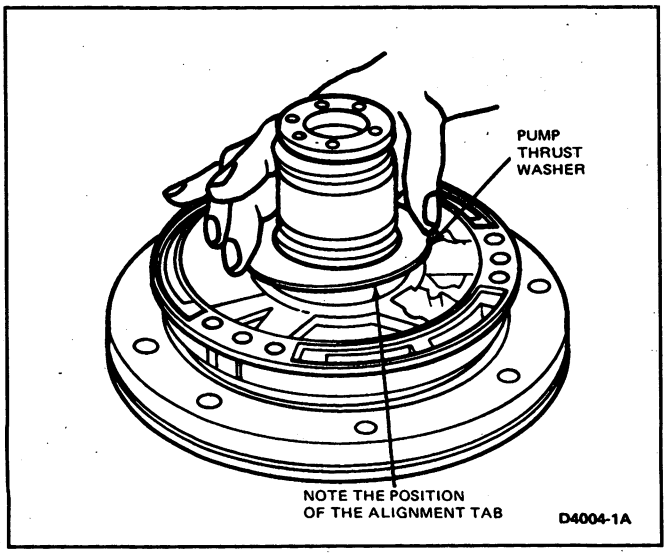


FIG. 85 Installing Selective Washer

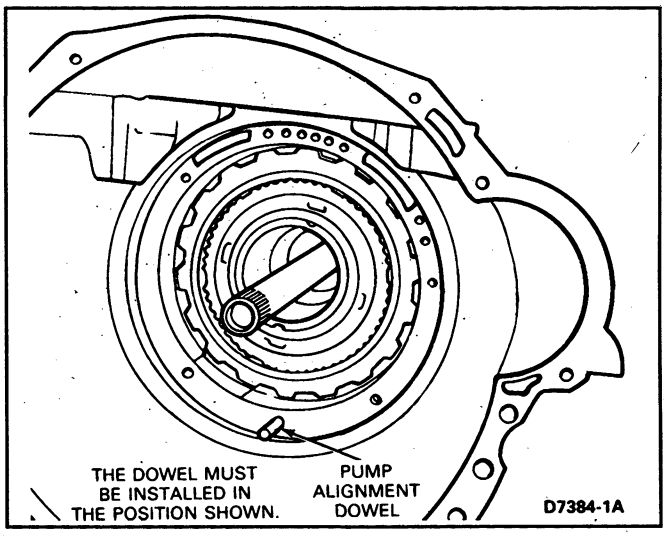


FIG. 86 Installing Pump Alignment Dowel

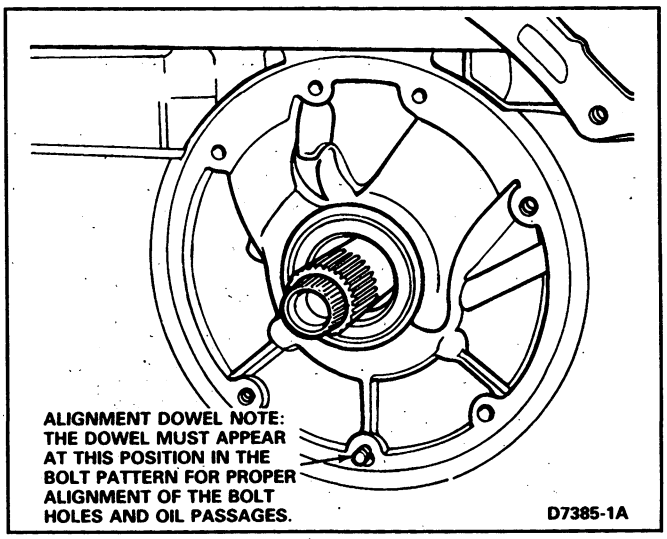


FIG. 87 Correct Front Pump Installation

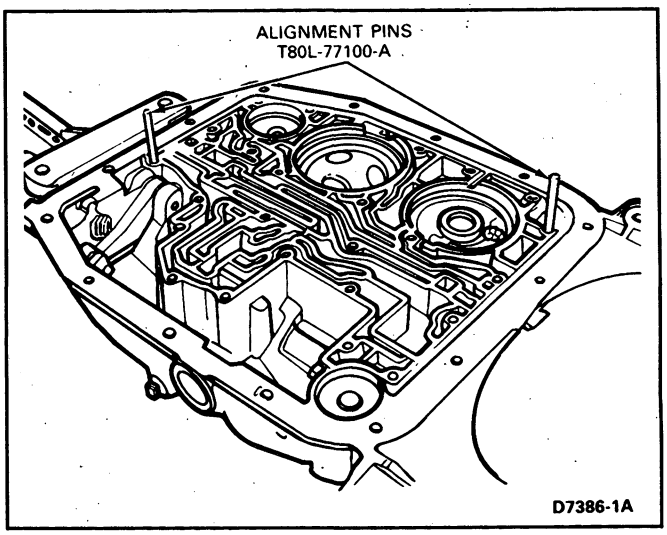


FIG. 88 Installing Valve Body Alignment Pins

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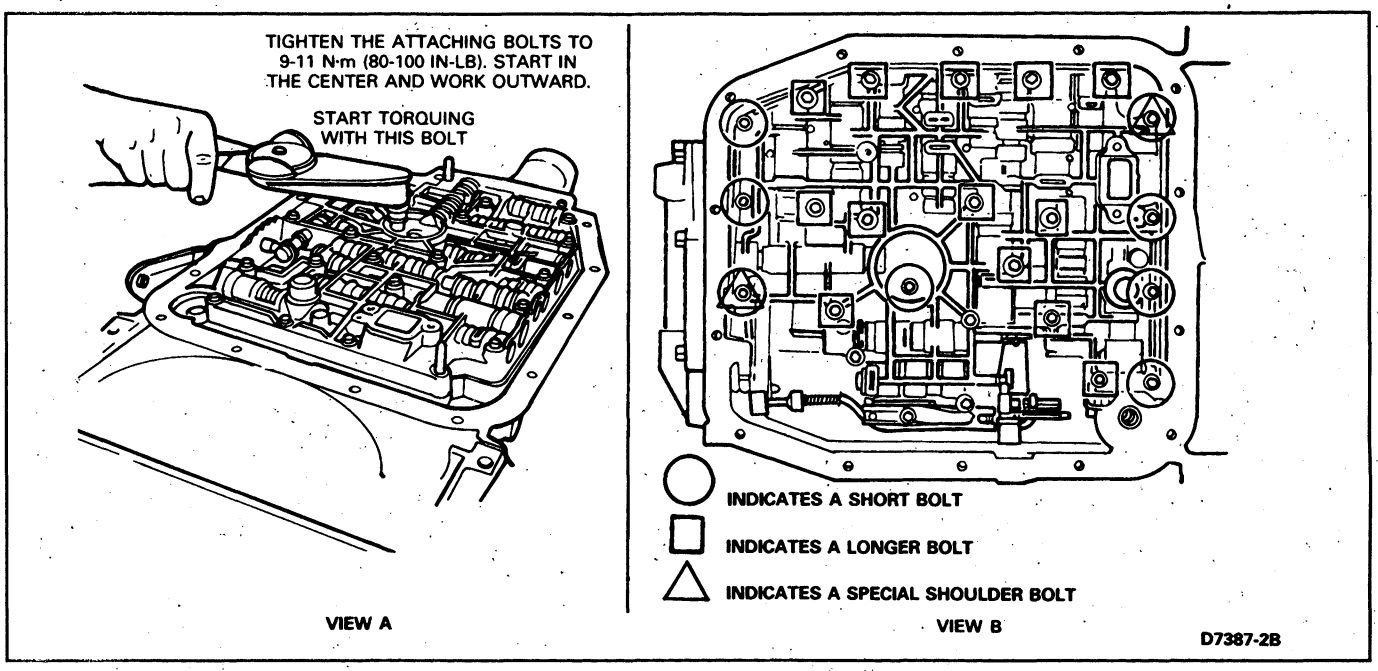


FIG. 89 Valve Body Installation

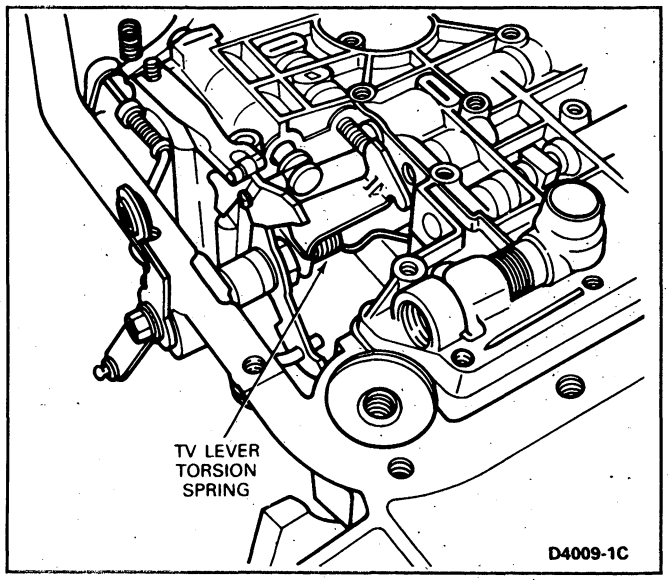


FIG. 90 Torsion Spring Installation

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SPECIFICATIONS

Clutch Pack Plate Usage and Clearance

SPECIFICATIONS
CLUTCH PACK PLATE USAGE AND CLEARANCE

FORWARD CLUTCH

Transmission Model	Steel	Friction	Clearance	Selective Snap Rings-Thickness
Models with 4.9L (300 CID) EFI and 5.0L (302 CID) EFI	5*	5	0.050-0.089	0.060-0.064
				0.074-0.078
				0.088-0.092
				0.102-0.106

*Plus a waved plate (Installed next to piston)

REVERSE CLUTCH

Transmission Model	Steel	Friction	Clearance	Selective Snap Rings-Thickness
Models with 4.9L (300 CID) EFI and 5.0L (302 CID) EFI	3	4	0.040-0.075	0.060-0.064
				0.074-0.078
				0.088-0.092
				0.102-0.106

DIRECT CLUTCH

Transmission Model	Steel	Friction	Clearance	Selective Snap Rings-Thickness
All	5	5	0.050-0.067	0.050-0.054
				0.064-0.068
				0.078-0.082
				0.092-0.096

INTERMEDIATE CLUTCH

Transmission Model	Steel	Friction	Gauge Dim.	Selective Steel Plates-Thickness
All	3	3	1.634-1.646	0.067-0.071
				0.077-0.081
				0.087-0.091
				0.097-0.101

Low-Reverse Servo Piston Travel - 0.108-0.241

Note: Piston travel can be adjusted using one of the selective servo pistons available for service.

SELECTIVE SERVO PISTONS

Rod Length*	I.D.	Rod Length*	I.D.	Rod Length*	I.D.
2.936	1 Groove	2.989	2 Groove	3.043	3 Groove

*Measured from the base of the piston to the end of the rod

Transmission End Play

Note: Transmission end play can be adjusted using one of the selective thrust washers available for service. After measuring the depth, install the required thrust washer.

SELECTIVE THRUST WASHER*

Depth	Thickness	Color Code	Depth	Thickness	Color Code
1.483-1.500	0.050-0.054	Green	1.535-1.551	.102-.106	Red
1.501-1.517	0.068-0.072	Yellow	1.552-1.568	.119-.123	Blue
1.518-1.534	0.085-0.089	Natural			

*The thrust washer is located on the stator support which is attached to the back of the pump housing.

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CLUTCH AND BAND APPLICATION CHART

	Interm. Friction Clutch	Interm. One-Way Clutch	Overdrive Band	Reverse Clutch	Forward Clutch	Planetary One-Way Clutch	Low-Reverse Band	Direct Clutch
1st Gear Manual Low					Applied	Holding	Applied	
2nd Gear Manual Low	Applied	Holding			Applied			
1st Gear - Ⓓ or D					Applied	Holding		
2nd Gear - Ⓓ or D	Applied	Holding			Applied			
3rd Gear - Ⓓ or D	Applied				Applied			Applied
4th Gear - Ⓓ	Applied		Applied					Applied
Reverse (R)				Applied			Applied	

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TORQUE CHART

Application	Torque	Application	Torque
Stator Support to Pump Body	16-22 N•m (12-16 ft-lbs)	Governor Body Cover Plate to Governor Body	2.3-3.4 N•m (20-30 in-lbs)
Front Pump to Case	22-27 N•m (16-20 ft-lbs)	Inner Manual Lever to Shaft	26-37 N•m (19-27 ft-lbs)
Reinforcing Plate to Valve Body	9-14 N•m (80-120 in-lbs)	Outer Throttle Lever to Shaft	16-22 N•m (12-16 ft-lbs)
Separator Plate to Valve Body	9-14 N•m (80-120 in-lbs)	Cooler Connector Line to Case	24-31 N•m (18-23 ft-lbs)
Valve Body to Case	9-11 N•m (80-100 in-lbs)	Converter Plug to Converter	11-38 N•m (8-28 ft-lbs)
Filter to Valve Body	9-14 N•m (80-120 in-lbs)	Neutral Start Switch to Case	11-15 N•m (8-11 ft-lbs)
Oil Pan to Case	8-14 N•m (6-10 ft-lbs)	Pressure Plug to Case	8-16 N•m (6-12 ft-lbs)
Extension to Case	22-27 N•m (16-20 ft-lbs)	Transmission to Engine	55-68 N•m (40-50 ft-lbs)
Governor Body to Counterweight	6-7 N•m (50-60 in-lbs)		

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SPECIAL SERVICE TOOLS

Number	Description
T50T-100-A	Impact Slide Hammer
T59L-100-B	Impact Slide Hammer
T58L-101-B	Shift Shaft Seal Remover
T57L-500-B	Bench Mounted Holding Fixture
TOOL-1175-AC	Front Pump Seal and Rear Case Bushing Remover
TOOL-4201-C	Dial Indicator with Bracketry
T82L-7006-A	Air Pressure Check Plate
T82P-7006-C	Capscrews (M6x16) for use with Air Pressure Check Plate
T67P-7341-A	Shift Linkage Insulator Tool
T84P-7341-A	Grommet Remover
T84P-7341-B	Grommet Replacer
T61L-7657-A	Extension Housing Seal Replacer
T77L-7697-A	Extension Housing Bushing Remover
T83L-7902-A	Converter Checking Tool
TOOL-7000-DE	Air Nozzle
T71P-19703-C	O-Ring Pick
D80L-77001-A	T.V. Pressure Fitting
T80L-77003-A	End Play Gauge Bar
T80L-77005-A	Intermediate Clutch Lip Seal (Inner and Outer) Protector
T80L-77030-A	Servo Piston (Reverse) Selection Tool
T80L-77030-B	Servo Piston Remover (Also Used for Air Pressure Checks)
T80L-77034-A	Extension Housing Bushing Replacer
T73P-77060-A	Snap Ring Plier
T80L-77100-A	Valve Body Guide Pins (2)
T80L-77103-A	Front Pump Adapter Remover (2)
D80L-77001-A	TV Control Pressure Adapter Fitting
T80L-77110-A	Rear Case Bushing Replacer
T80L-77140-A	Forward Clutch Lip Seal Protector (Inner)
T80L-77234-A	Lip Seal Protector (Inner)
T74P-77247-A	Neutral Start Switch Socket
T74P-77248-A	Extension Housing Seal Remover
T80L-77254-A	Lip Seal Protector (Outer)
T80L-77268-A	Front Pump Bushing Replacer
T80L-77268-B	Front Pump Bushing Remover
T80L-77403-A	Reverse Clutch Seal Protector (Outer)
T80L-77403-B	Reverse Clutch Seal Protector (Inner)
T80L-77405-A	Reverse Clutch Spring Compressor Plate
T74P-77498-A	Front Pump and Shift Shaft Seal Replacer
T65L-77515-A	Clutch Spring Compressor
T80L-77515-A	Forward Clutch Spring Compressor Adapter
T68P-7D158-A	Forward Clutch Lip Seal Protector (Outer)
T63L-77837-A	Front Pump Seal Replacer
T86L-70332-A	Cable TV Control Pressure Gauge Tool
T86L-70002-A	TV Pressure Gauge with Hose

CD4805-2G

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AUTOMATIC TRANSMISSION REFILL CAPACITY — AOD AUTOMATIC TRANSMISSION

Vehicle	Transmission Type	Engine	Approximate Refill Capacity*		
			U.S. Quarts	Imperial Quarts	Liters
E-150 — E-250, F-150 — F-250 (4x2) (4x4) Bronco (4x4)	AOD #	5.0L (302 CID) EFI 4.9L (300 CID) EFI	12.3	10.2	11.6

*Approximate dry capacity, includes cooler and lines. Fluid level indicator should be used to determine **actual** fluid requirements and fluid specifications. Check level at normal operating temperature. **DO NOT OVERFILL.**

If it is necessary to add or replace fluids, use only fluids which have been certified by the supplier as meeting one of the Ford Motor Company specifications shown below:

#AOD transmissions — Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX (E4AZ-19583-B). **CD4934-2F**

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NOISE, VIBRATION AND HARSHNESS DIAGNOSIS

GROUP 18

SECTION 18-01 Noise, Vibration and Harshness Diagnosis

SUBJECT	PAGE
ADJUSTMENTS AND SERVICE	
Brake Drum Balancing	18-01-13
Driveshaft Balancing	18-01-13
DESCRIPTION	
Harshness	18-01-2
Noise	18-01-1
Noise Acceptability	18-01-1
Vibration	18-01-1
Typical High-Speed Vibrations (Above 72 km/h or 45 mph)	18-01-2
Typical Low Speed Vibrations (Less than 72 km/h or 45 mph)	18-01-2
DIAGNOSIS AND TESTING	
Diagnosis	18-01-3
Match Mounting Tires	18-01-6
DIAGNOSIS AND TESTING (Cont'd)	
Match Mounting Tires (Cont'd)	
Analysis of Gear Noise	18-01-11
Drive Axle Noise	18-01-9
Driveline Angle Check	18-01-9
Driveline Vibration	18-01-9
Engine Accessory Vibration	18-01-9
Tip-In Moan	18-01-7
N.V.H. Tests and Operations	18-01-3
Testing	18-01-4
Vehicle Vibration Analysis Procedure	18-01-4
High-Speed Shake	18-01-4
GLOSSARY OF TERMS	18-01-13
SPECIAL SERVICE TOOLS	18-01-15
VEHICLE APPLICATION	18-01-1

VEHICLE APPLICATION

Bronco, E-150—E-350, F-150—F-350 (4x2/4x4) and F-Super Duty Vehicles.

DESCRIPTION

Noise

Noise, defined as any unpleasant sound, may be described in a variety of ways such as tapping, whistling, buzzing, humming, clunking, or booming. You can associate these various descriptions of noise with a probable cause. Based on experience, these descriptions will assist in isolating the problem and correcting it. Generally recognizable problem areas are engine, drivetrain, wind and road surface noises. Other less obvious areas that should be considered as noise problem sources are any of the problems that cause the vibrations described in the following Section.

Noise Acceptability

A gear driven unit, especially a drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions: for example, tire noise on a newly paved blacktop road. Such noise is in no way detrimental to the operation of the vehicle and must be considered normal. Similarly, camshaft belt whine, most often associated with new belts used on the smaller engines, will usually go away after belt break-in.

NOTE: It is important that the rear axle noise on vehicles equipped with either a manual or automatic overdrive transmission be evaluated in direct drive rather than overdrive.

Vibration

Vibration, technically, is a high-frequency trembling, shaking or grounding condition, felt or heard, that is

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constant or variable in level and occurs during a portion of the total operating speed range. The types of vibrations that can be felt in the vehicle can be divided into three groups:

1. Vibrations of various unbalanced rotating parts of the vehicle.
2. Body and frame vibrations excited by powertrain, wind or road inputs.
3. Tip-in moans or resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

These vehicle vibrations can also be subdivided into those that occur at low speeds and those that are most noticeable at higher speeds. Since the dividing line between low and higher speed vibrations is not clear, there will be vibrations that overlap the two ranges.

Typical Low Speed Vibrations (Less than 72 km/h or 45 mph)

- Engine harshness.
- Improper driveline angles.
- Power steering pump disturbances.
- Air conditioner compressor or drive belt vibrations.
- Take-off shudder.
- Brake roughness or harshness.
- Driveline roughness.
- Clutch torsion vibration.
- Exhaust vibration.
- Tire roughness due to high non-uniformity (force variation).

Typical High-Speed Vibrations (Above 72 km/h or 45 mph)

- Excessive tire-wheel and drum assembly imbalance.
- Excessive tire and wheel run-out.
- Companion flange runout or imbalance.
- Driveshaft imbalance noise.
- Rear axle pinion gear pitch line runout.
- Galled, dirty, rusty, worn or improperly lubricated driveline slip yoke splines or U-joint bearings.
- Worn suspension components.

Harshness

Harshness is the term commonly used to describe the ride quality of the vehicle. Hard ride or harshness is usually caused by the tires or suspension system, namely:

- Over-inflated, wrong size or wrong type tire installed on the vehicle.
- Suspension not sufficiently lubricated.
- Worn suspension components.
- Suspension components installed with preload on pivot points, bearings and bushings.
- Units equipped with tires not specified by the manufacturer. (Different brand tires often give different ride qualities to vehicle.)
- Bent or bound-up shock absorbers.
- Heavy-duty components installed on vehicle.
- Improper installation of body or cab mounts (ground outs).

Other vehicle ride motions may be summarized as follows:

- Vehicle Bounce—The vertical motion of a vehicle on its suspension system, front and rear in phase. A low frequency "float," an intermediate frequency "kick."
- Vehicle Pitch—The out-of-phase vertical motion of the front and rear of the vehicle. A flat ride would be considered the opposite of a pitch ride.
- Vehicle Roll—The side-to-side rotation of the vehicle body about the front and rear axles.

DIAGNOSIS AND TESTING

Noise, vibration, and harshness (N.V.H.) usually occurs in four areas: tires, engine accessories, suspension and drive line.

It is important, therefore, that an N.V.H. problem be isolated into its specific area as soon as possible. The easiest and quickest way to do this, is to perform a thorough road test if a visual inspection does not readily pinpoint the problem. After performing the Road Test Check, isolate the probable cause of the condition using the Road Test Diagnosis Chart. Use the appropriate diagnostic procedure chart and/or guide to determine the area of investigation.

Road Test Diagnostic Guidelines

Some hints on performing a road test for the diagnosis of NVH complaints.

A very useful first step in the road test is a neutral engine run up (NERU) test. It identifies engine related vibrations and helps in sorting out vibrations that are found in the road test.

If the vehicle is equipped with a tachometer, it can be used. Otherwise, a tach should be connected. A tach is absolutely necessary in both the NERU test and the road test.

Locate the vehicle away from other vehicles and walls which may reflect sound differently than a road reflects sound. Put the vehicle in neutral (an automatic transmission may be tested in Park) and do not set the parking brake or press on the service brake since these are not engaged in a road test. Pressing on the service brake puts forces into the brake and clutch pedal support and into the firewall that are not present in driving. A similar situation arises with the parking brake.

Run the engine up from idle to approximately 400 rpm and note any moans, vibrations, noises, etc and the rpm at which they occur. Sometimes it is possible to "tune in" on these by running up and down in rpm and to determine a precise rpm at which they occur, in other cases they will fall over a broad range of rpm. This establishes a baseline against which driving vibrations can be measured.

If you suspect that the exhaust system is vibrating, attach a ring of keys or something similar to the tailpipe and listen for the rattling of the keys as the engine is run up and down. Sometimes it is very clear with just this simple test that the exhaust system is responsible.

When conducting the road test refer to the results of the NERU test to sort out vibrations and noises caused by the engine from those caused by the transmission, driveshaft or axle. If a vibration or noise occurs at a

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particular speed, try operating in another gear at the same speed. This changes the engine rpm and helps to sort out engine induced vibrations and noises. If it occurs at a particular rpm, use different gears to test at the same rpm at different speeds.

If the vehicle has an automatic transmission, a drive engine run up test (DERU) can be conducted. In this case both the parking brake and service brake should be set and care should be taken to perform the test with enough space ahead of the vehicle to eliminate the possibility of an accident should the vehicle unintentionally lurch forward. Put the transmission in Drive and run the engine up and down between idle and approximately 2000 rpm and note the nature of any vibrations and noises and the rpm. This test is particularly good for exciting the exhaust system and hanging keys on the tailpipe to serve as a "telltale" is useful.

The NERU test takes only a minute or two and represents time well spent in testing.

The road is an important factor in the road test and a smooth asphalt road that allows driving over a range of speeds is best. The brushed concrete road surface found on many expressways and the coarse aggregate sometimes found in asphaltic concrete can mask many vehicle noises and make diagnosis difficult.

If the customer complains of a noise or vibration on a particular road and only on a particular road, the source of the problem may be the road surface. If possible, try to test on the same type of surface. This is the only case where a smooth asphalt road may not be the best.

Check and set tire pressure. Unlock the front hubs and back up approximately 20 feet to ensure hub disengagement if the vehicle is a 4x4. Remove the cross bows of the roof rack if the vehicle has this option. (The Bronco II roof rack produces a whining noise that interferes with NVH diagnoses.) A tachometer should be used as noted above. Note the fuel level. Some vehicles change in their response to various excitations when the fuel level changes. If the customer mentions that the problem does not occur all the time, this might be a factor.

Try to duplicate the conditions described by the customer, particularly the speed and throttle operation. It is not uncommon to find problems which the customer didn't notice so it is important to identify the problem causing the complaint.

When diagnosing driveline NVH complaints, the following procedure is useful.

Find the speed where the problem is most severe. Then accelerate gently through this speed to a few mph above it and then coast back down a few mph below it and note if the problem changes character when driving through or coasting down. Repeat this if necessary to get a feeling for the behavior. Then drive about five mph above the speed, put the transmission in neutral and coast down. Note any change in behavior. Try "floating" the driveline by backing off ever so slightly on the throttle at the problem speed. The idea is to unload the axle gears and the universal joints as much as possible. This is a difficult test to master and sometimes it helps to test on a slight downgrade so that gravity is counteracting the aerodynamic drag. The throttle should be operated in much the same way it is operated when shifting out of gear without using the clutch. In that case, the throttle is used to unload the transmission gears; here it is used to unload the driveline in general.

If the problem does not change in all these modes of operation, the cause may well be driveline imbalance since the imbalance is not changed by the mode.

If there is a distinct change in the character or intensity between the drive and coast modes of operation the problem is most likely not imbalance but is most likely due to the axle or the universal joints since they are sensitive to the load on the driveline. (The axle pinion gear teeth are machined on two separate machines. One machine does the drive side of the teeth, another does the coast side. Hence there can be a great difference in performance between driving and coasting in gear.) If the noise and/or vibration goes away when the driveline is "floated" or when coasting through the speed in neutral, the diagnosis is strengthened. Imbalance does not go away in a neutral coast but axle and joint problems may.

One way to "calibrate" yourself to the symptoms of imbalance is to take a similar vehicle which does not have the symptoms and to intentionally imbalance the driveline by putting a hose clamp on the driveshaft. This gives you a feel for imbalance. Unfortunately, there is no easy way to simulate other sources of problems.

After a road test, but only after a road test, it is sometimes useful to do a similar test on a hoist. (Use an axle hoist, not a frame hoist. An axle hoist will not change the driveline angles. If only a frame hoist is available, short axle stands should be used.) Elevate the rear wheels slightly, check to make sure that both are turning, and run the engine up with the vehicle in gear. Explore the speed range of interest using the drive/cruise/coast/float tests as previously described above. A coast down in neutral should also be conducted. If the vehicle is free of vibration when operating at a steady indicated speed and behaves very differently in drive and coast, an axle problem is likely.

Note, however, that a test on the hoist may produce different vibrations and noises than a road test because of the effect of the hoist on the rear axle. It is not unusual to find vibrations on the hoist that were not found in the road test and many times these may be ignored. If the problem that was found on the road can be duplicated on the hoist, a great deal of time can be saved by doing experiments on the hoist.

N.V.H. Tests and Operations

A gradual appearance of the problem indicates a deterioration of a component, such as tires, U-joints, an accessory drive belt, or a wheel bearing.

A sudden appearance of the problem could indicate a lost wheel balance weight or lost driveshaft balance weight.

NOTE: Information gained from the problem description should never be used in place of facts gained from diagnosis, nor should it be used in an attempted short cut fix. In the long run, time will be saved by adhering to the diagnostic procedures shown in this Section.

Diagnosis

Use the four diagnosis guides in this Section to identify the Noise, Vibration or Harshness condition. When the condition is isolated, refer to the appropriate portion of Testing in this Section.

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Testing

Vehicle Vibration Analysis Procedure

1. Problem Definition:
   a. Ask customer to explain the problem.
   b. Neutral engine runup. Run engine up to problem RPM so any engine accessory problem can be eliminated.
   c. Ride in vehicle and experience the vibration described by owner (with owner if possible). Note speed and suspect wheel position.
2. Initial Checks:
   a. Tire Matching—Tire size and type match.
   b. Inflation Pressure—Correct inflation pressure.
   c. Appearance—Check for wear and condition of tires and wheels.
   d. Rim Centering—Check that tire beads are properly seated.
3. Tire Runout Check on Vehicle:
   a. Runout okay—Go to dynamic balance check below.
   b. Excessive runout—Refer to match mounting procedure.
   c. High runout still present—Refer to wheel stud runout procedure. (Step 7 under High Speed Shake).
   d. Replace high runout wheels or tires when required—Go to dynamic balance check below.
4. Dynamic Balance:

Mark a wheel stud and the corresponding position on the rim to ensure that the assembly can be replaced on the vehicle in its original position. Do not remove existing balance weights. If rebalance only requires 1/2 oz. or less on either flange, the problem is not imbalance; proceed to ride test.

If problem is balance, rebalance and continue to road test.

Never add more than 5 oz. of weight per flange on a Ford Light Truck tire. If more weight is required:

   a. Spin the assembly on the balancer in static mode.
   b. Mark the location and amount of weight required on the sidewall. Do not balance assembly.
   c. Remove assembly from the balancer, deflate and rotate tire halfway around (180 degrees) as in matching for runout.
   d. Reinflate, replace on balancer and respin a second time in static mode.
   e. Mark location and amount of weight required on sidewall.
   f. If your two marks are within 4 inches of each other, it is the tire that is the major contributor to imbalance. (The marks followed the tire when it was rotated.) Replace tire.
   g. If your two marks are within 4 inches of being opposite each other on the tire, then the wheel is out of balance. Replace wheel.
   h. If the two marks are neither opposite nor together, then the assembly can be match mounted for static balance. Refer to match mounting procedure.
5. Road Test:
   a. Problem eliminated—Stop.
   b. Vibration is still present check:

      Brake drum imbalance
      Engine or transmission mounts
      Excessive drive shaft runout or imbalance
      Improper pinion angle
      Faulty universal joints
      Worn or damaged wheel bearings
      Brake rotor imbalance

High-Speed Shake

This is a low-frequency, high-amplitude, visible vibration felt in floor pan, seats and steering column at speeds above 72 km/h (45 mph), and may be visible in front end sheet metal. The cause is usually found in the wheel/tire/rotor/drum/axle area, arising from imbalance, run-out, bearing play, tire irregularities, etc. Visible sheet metal shake, though usually just another symptom of wheel-and-tire problems, may be indicative of improper tightening or adjustment of sheet metal mounting hardware. This condition, in conjunction with aerodynamic buffeting forces in some vehicles, especially trucks, can be a primary source of shake. If such shake is observed, inspection and tightening of sheet metal mountings may correct the problem.

1. After verifying the shake condition on the road test (at least 10 miles to remove flat spots from nylon cord tires), promptly raise the vehicle on a twin-post hoist or axle jack stands so that the tires do not develop flat spots while cooling off. Inspect tires for extreme wear or damage, or irregularities such as cupping or flat spots (see Fig. 1). If found, check the suspension components for misalignment, abnormal wear, or damage that may have contributed to the tire problems. Correct any suspension problems, and replace the damaged tires.
2. Spin the front wheels by hand (rear wheels on front-wheel-drive models) to check for wheel bearing roughness. Also check for end play. If bearings are loose or rough, adjust or replace and lubricate as necessary. On 4 x 4 models equipped with locking front hubs, unlocking the hubs will free wheels for bearing checks. Without unlockable hubs, removal of the hub cover is necessary to disengage the axle shafts.
3. Spin the non-driving wheels at low speed with a wheel balance spinner, observing for visible wheel/tire run-out. If run-out is evident, proceed to wheel/tire run-out checks, Steps 8 and 9. If run-out is not evident, balance the non-driving wheels and proceed to Step 4. Front wheels on 4 x 4's, if equipped with locking hubs, can be spun with hubs unlocked, or engine-driven with front drive engaged, for run-out checks.
4. With drive train engaged, carefully accelerate the drive wheels until shake is felt. Without road load, the shake may be aggravated, and become extreme at lower speeds than observed in the road test. Accelerate up to the road test speed if

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necessary to bring out the shake. For 4 x 4's, run the test with front drive both engaged and disengaged, and note any difference. If shake appears, proceed to Step 5. If little or no shake is evident and a front-wheel condition has been found and corrected, repeat the road test to see if the problem still exists. If it does, check wheel/tire run-out (Steps 8 and 9).

5. If shake is evident on the hoist run-up, mark the positions of the drive wheels relative to the wheel studs. Remove the wheels, secure the brake drums, if so equipped, by installing all lug nuts (if one piece cone style), reversed, and repeat the run-up to road speed. If shake is eliminated, the problem is probably wheel imbalance or run-out. Before proceeding to run-out checks, verify that rear axle shaft run-out is within limits (Step 7).
6. If vibration is evident with the rear wheels off, remove the brake drums and repeat the road-speed run-up. If the shake is gone, brake drum imbalance or run-out is indicated, but brake run-out may be caused by axle run-out, which should be checked (Step 7). Check brake drum balance on a bubble-type static balancer, and replace or machine out-of-balance drums. If loss of balance weight is evident, and re-balancing is warranted, refer to brake drum balancing in this Section. If shake persists in the drums-off test, refer to Driveline Vibration in this Section under testing.
7. Remove brake drums, if not already removed, to expose the axle shaft flange. Indicate the flange face lateral run-out (Fig. 2), the drum/rotor pilot radial run-out (Fig. 3), and the wheel bolt circle radial run-out (Fig. 4). (Read each wheel bolt in turn with a broad-foot indicator as close to the axle flange as possible, being careful not to jar the indicator out of position from one reading to the next. Note the highest and lowest readings.) Compare total indicator readings (T.I.R.'s) with the runout.

   If any run-out value exceeds specification limit, replace the axle shaft or hub. Check for radial play in rear axle bearings, or evidence of roller damage to bearing inner race surfaces on the axle shafts. Replace axle shaft if bearing journal is damaged. Replace bearings if loose or rough.
8. Re-install driving wheels and tires in original positions. Check all wheels for total radial and lateral tire run-out, using Rotunda Gauge 007-00014, or equivalent, as illustrated in Fig. 5. If

Diagnosis Guides

ROAD TEST DIAGNOSIS

Condition	Possible Source	Refer to (Procedure)
Visible shake in floor pan, seats, steering column and/or front end sheet metal at highway speed, 72 km/h (45 mph) and up.	Wheel/tire/axle/brake imbalance or run-out.	High-Speed Shake.
Vibration felt or heard at highway speed, 72 km/h (45 mph) and up. Evident at steady speed, or under light acceleration or deceleration.	Driveline or drive axle imbalance or run-out. Engine mounts grounded. Exhaust system bound-up.	Driveline Vibration. Tip-In Moan, Step #3. Tip-In Moan, Step #4.
Shudder or rumble on heavy acceleration or deceleration, 0-72 km/h (45 mph).	Incorrect driveline angle(s).	Driveline Angles Check.
Moaning noise, and possible belt vibrations, on light acceleration or deceleration between 40 and 104 km/h (25-65 mph).	Engine or exhaust mounts bound up, powertrain components grounding, or undamped powertrain resonance.	Tip-In Moan.
Engine-rpm-related vibration or noise that disappears in Neutral-Coast drive mode, and appears in standstill engine run-up at specific rpm.	Engine accessory drive or mount not properly adjusted or tightened, not running true, or accessory malfunction.	Engine Accessory Vibration.
Various hums, howls, whines or knocking noises that vary in intensity and pitch with road speed, and may or may not respond to drive mode changes.	Drive axle gear or bearing wear, damage or improper adjustment.	Drive Axle Noise.
Low frequency booming noise or pressure felt in ear drums, which occurs at or just above idle.	Engine or exhaust mounts bound-up.	Tip-In Moan, Steps #3 and #4.

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GENERAL NOISE DIAGNOSTIC PROCEDURE

CONDITION	POSSIBLE SOURCE	
• Noise is the same on drive or coast.	• Road noise • Tire noise • Front wheel bearing noise	• Pinion Bearings • Rear wheel bearings
• Noise changes with type of road surface.	• Road noise	• Tire noise
• Noise tone lowers as vehicle speed is lowered.	• Tire noise • Driveline noise	
• Similar noise is produced with vehicle standing and driving.	• Engine noise	• Transmission noise
• Noise most pronounced on turns.	• Differential side gears and pinion gears	
• Drive noise, coast noise, or float noise.	• Wheel bearings • Ring and pinion gear	• Axle shaft surface finish at bearing bore
• Clunk on acceleration or deceleration.	• Inoperative throttle damper • Excessive differential gear backlash • Excessive ring and pinion gear backlash • Transmission backlash	• Loose engine mounts • Worn driveshaft U-joints • Worn driveshaft slip yoke splines • Loose suspension components • Sticking slip yoke

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either is over 1mm (.040 inch), check the wheel rim run-out, radial and lateral (Fig. 5). If either 1mm (.040 inch), replace the wheel and re-check run-out. If the rim is within limits, locate and mark the low point of rim radial run-out.

9. If rim run-outs are within limits and total lateral (tire) run-out is over 1mm (.040 inch), replace the tire. If total tire **radial** run-out is more than 1mm (.040 inch), mark the highest point of the tread, dismount, re-index and remount the tire with the high point aligned with the low point of the wheel. Re-check radial tread run-out, and if still more than 1mm (.040 inch), replace the tire and re-check run-outs, re-indexing as necessary to bring radial run-out within limits.

NOTE: When remounting tires, to assure accurate centering, use plenty of rubber lubricant on rim and tire bead, over-inflate to seat the bead (as recommended by tire manufacturer), then bleed pressure down to pressure noted on specification label.

10. Balance all wheels not previously balanced, using on-vehicle balancing equipment if available. Road test the vehicle. If the problem has not been eliminated, proceed to Step 11.

11. Substitute a known-good set of wheels and tires, and road test. If shake is gone, the problem was probably caused by tire force variation, resulting from non-uniform tire construction. Re-install the original tire/wheel assemblies one-by-one, road testing at each step, until the worn or damaged tire(s) is identified. Replace tire(s) as necessary and retest. If shake persists with substitute wheels, refer to Driveline Vibration in this Section under Testing.

Match Mounting Tires

Match mounting is a technique used to reduce radial or lateral tire runouts on tire and wheel assemblies. Excessive runout is a source of ride complaints and match mounting can be used to minimize the runout. There are two ways to use match mounting: 1. positioning of the tire on the wheel; and 2. positioning the wheel on the hub.

1. Measure the total indicated runout on the center of the tire tread rib, and record it. Mark the tire and rim at the center of the tread rib, and record the reading. Mark the tire at the location of the valve stem for reference.
2. Break down the tire and remount it 180 degrees on the rim so that the valve stem reference mark is opposite of the valve stem on the wheel.
3. Reinflate the tire and measure the total indicated runout, and again mark the high spot.
4. If the runout is reduced to acceptable guidelines the tire is ready to be put back into service. If the runout is still excessive, one of the following steps must be performed:
   - If the high spot is within 4 inches of the first high spot on the tire, and is still outside of guidelines, replace the tire.
   - If the high spot is within 4 inches of the first high spot on the wheel, the wheel may be out of tolerance, check the wheel for runout.
   - If the high spot is not within 4 inches of either original high spot of the tire and rim, then draw an arrow from the second high spot to the first high spot (in the shortest direction) and rotate the tire on the rim 90 degrees in that direction.

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DIAGNOSIS GUIDE	
Non-Axle Noises	
• Grille Whistle • Trim Moulding • Roof Tip Luggage Rack	• Exhaust • Tires • After Market Add On's. Running Boards, Grounding Body to Frame, Antennas, Visors, Bug Deflectors, etc.
Noise Conditions	
• Gear Howl and Whine — Inspect Gear Set — Check Gear Set Backlash	— Check Ring Gear Run-out — Check Bearing Preload
• Chuckle Noise — Differential Gear Clearance	— Mutilated Gear Teeth
• Knock Noise — Gear Tooth Mutilation — Ring Gear Bolts	— Axle Shaft End Play
• Clunk Noise — Total Axle Backlash — Worn Driveshaft U-joints — Loose or Broken Engine Mounts	— Worn Driveshaft Slip Yoke Splines — Axle Shaft Spline Fit — Inoperative Throttle Damper
• Bearing Noise — Pinion Bearing — Wheel Bearing — Differential Thrust Washer	— Limited-Slip Operation — Click on Engagement
Vibration Conditions	
• Tires • Driveline Angle • Universal Joint	• Axle Shaft • Drive Pinion Stem and Flange • Wheel Nuts
Leakage Conditions	
• Drive Pinon Seal • Drive Pinion Nut • Axle Cover Gasket • Axle Shaft Seals	• Casting Porosity (Holes in Casting) • Weld Leaks • Axle Vent and/or Hose
Inoperative Conditions	
• Broken Axle Shaft • Broken Pinion Stem • Broken Welds	• Wheel Bearing • Axle Lock-Up • Broken End Yoke • Broken U-Joint • Broken Gear Teeth

CF3392-2F

This will normally reduce the runout to an acceptable level.

In the majority of cases, the first 180 degrees turn of the tire will either fix the problem or indicate which item to replace.

Tip-In Moan

A moaning noise, possibly accompanied by a felt vibration, under light to medium acceleration between 40-104 km/h (25 and 65 mph), usually indicates a grounding or bound-up condition of power train component or exhaust system mounts. Another possible cause is a resonance condition at the natural vibration frequency of the engine. This type of vibration will usually peak at a specific engine speed (RPM) and degree of acceleration (throttle setting) at that speed.

1. Check air cleaner for proper installation of base gasket, lid, element and air inlet duct assembly. If damaged gaskets, or improper duct alignment or tightening of attaching nuts and bolts are evident, correct the condition and road test. If moan persists, proceed to Step 2.
2. To check for powertrain resonance, loosen all converter or clutch housing-to-engine attaching

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REAR AXLE DIAGNOSIS CHART

CONDITION	POSSIBLE SOURCE	RESOLUTION
• Excessive rear axle noise.	• Differential carrier	• Road test vehicle to assure problem is rear axle noise rather than other system noise. Refer to General Diagnostic Procedure. Service and replace parts as required.
• Loud "clunk" in the driveshaft when shifting from reverse to forward.	• Driveshaft	• Raise vehicle, rotate driveshaft by hand to isolate problem as driveshaft or rear axle problem. Service or replace as required.
	• Rear axle shaft or carrier	• Inspect and service as necessary.
• Limited-slip axle does not work in snow, mud or on ice.	• Differential	• Perform Traction-Lok Differential Operation Check. (Refer to Section 15-01, General Driving Axle and Driveshaft Service.) Service as required.
• On turns, the rear axle has a chattering noise (Limited-slip or Traction-Lok axles only). Slight chatter noise on slow turns after extended highway driving is considered acceptable and has no detrimental effect on the locking axle functions.	• Lubricant	• Road test vehicle. Drive vehicle in tight circles, five clockwise and five counterclockwise. If chatter is still evident, flush, replace lubricant with the required limited-slip lubricant.
	• Differential	• Remove differential, service as required.

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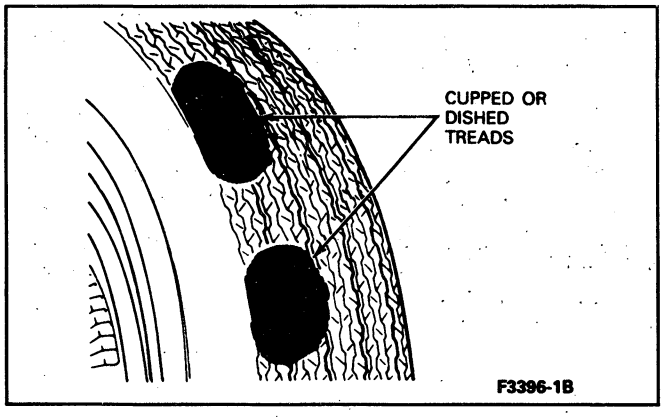


FIG. 1 Worn or Damaged Tires

bolts 3/4 turn and road test. Re-tighten bolts after test. If moan persists, proceed to Step 3.

3. Neutralize engine mounts by loosening them (Fig. 6) and, with engine running, shifting transmission from Neutral to Drive and back to Neutral. With manual transmission, load engine by slipping clutch in gear. Re-tighten mounts and road test. If moan persists, proceed to Step 4.

4. Neutralize the exhaust system to relieve strain on mounts which may be sufficiently bound up to transmit vibration as if grounded. First, be sure the system is warmed up to normal operating temperature, as thermal expansion could be the cause of a strain problem. Loosen all hanger attachments and flange joints. Reposition the hangers until they hang free and straight (see Fig. 7). Then with engine running, shift transmission from Neutral to Drive and back to Neutral (or load engine with clutch), and re-tighten all hanger clamps and flanges (tighten the manifold to exhaust flange joint last). Verify adequate clearance to prevent grounding at any point in the system. Road test the vehicle and if moan persists,

Run-out Limits	Flange Face Lateral	Drum/Rotor Pilot Radial	Wheel Bolt Circle Radial
Dana Axle	0.13mm (0.005 inch)	0.8mm (0.003 inch)	0.13mm (0.005 inch)
Ford Axle	0.13mm (0.005 inch)	0.10mm (0.004 inch)	0.36mm (0.014 inch)

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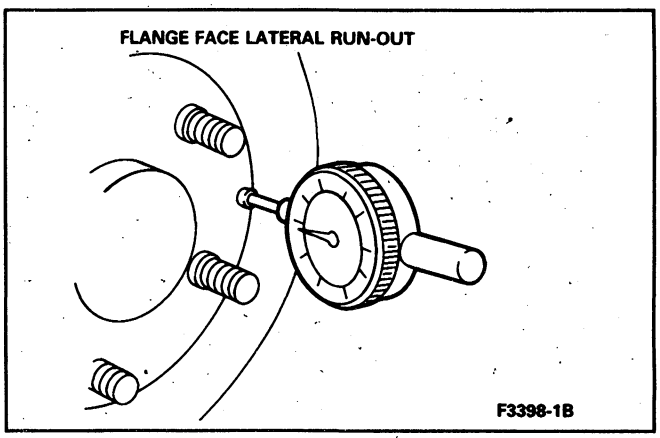


FIG. 2 Flange Face Lateral Run-out

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refer to Engine Accessory Vibration in this Section under Testing.

Driveline Vibration

This is a higher-frequency, lower-amplitude vibration than high-speed shake, directly related to road speed, and usually more noticeable at higher road speeds, 72 km/h (45 mph) and up. It is felt in the floor pan or heard as a rumble, hum or boom. It can exist in all drive modes, but may vary somewhat in acceleration, deceleration, float or coast modes. If the vibration is particularly responsive to heavy acceleration or deceleration, especially at lower speeds, driveline angles should be checked. A driveline vibration can sometimes be duplicated with the axle supported on a hoist or jack stands; through light brake application while accelerating and decelerating, to simulate road load resistance, may be necessary to bring it out.

For driveline vibration diagnosis and testing procedures, refer to Section 15-60, General Driveshaft Service.

Driveline Angle Check

A shuddering feel or audible rumble at speeds up to 72 km/h (45 mph), most pronounced under heavy acceleration or deceleration and reduced or eliminated in float or neutral-coast modes, usually indicates incorrect driveline angle, between driveshaft and rear axle pinion. Another possible cause is poor seating, tight or bound up U-joint trunnion or off-center mounting of U-joints. Driveline angularity is controlled by ride (spring) height, suspension control arm geometry or axle-to-spring shims in leaf spring applications, and center bearing alignment in two-piece shafts (truck). Whether incorrect angle effects are more pronounced under acceleration, or deceleration, depends on whether ride height or pinion angle deviations from specification are plus or minus. The condition usually cannot be duplicated on the hoist because considerable road load torque resistance is required to bring it out.

For driveline angle checking procedures, refer to Section 15-60, General Driveshaft Service.

Engine Accessory Vibration

A noise or vibration that occurs at different road speeds in different gears, but always at the same engine rpm, probably originates in an engine-driven accessory. This type of vibration will disappear in neutral-coast drive mode, and can be duplicated in an engine run-up to the problem speed with the vehicle standing still. It may be caused by a loose, worn or damaged drive belt, a damaged, worn or untrue drive pulley, improperly aligned or tightened accessory mounting brackets or hardware, or worn, damaged, or out-of-true conditions in an accessory itself.

1. Run-up engine to the problem rpm observed in the road test, with vehicle stationary. If vibration is not evident, perform stall test in Drive with brakes locked (or load engine by slipping clutch in gear with manual transmission). If condition appears under load, see Tip-In Moan procedure. If condition appears on no-load test, proceed to Step 2.

CAUTION: Load tests must be of short duration to minimize torque converter or clutch overheating. If vibration does not appear under load, a more careful road test may suggest driveline vibration as the real problem.

2. With engine stopped, inspect all engine accessory drive belts and pulleys for wear or damage, and check belt tension, using Tool T63L-8620-A or equivalent (Fig. 8). Check all accessory mounting brackets and adjusting hardware for proper alignment and tightness. Replace worn or damaged drive components, correct belt tension and tighten mounting hardware to specification. Start engine and run-up to the problem speed. If vibration or noise persists, proceed to Step 3.
3. With engine idling, visually check all accessory drive belts and pulleys for misalignment, run-out or irregular motion. Replace any pulley with run-out in excess of 3mm (1/8 inch). A belt that is seen to ride up and down in a pulley groove indicates a variable-width condition, either in the belt or in the pulley. If it only happens on one pulley, replace the pulley. Otherwise, replace the belt. When all accessory drives run true at idle, run engine up to the problem speed and look for belt whip. If observed, adjust the belt tension to specification and re-check. If whip persists, replace belt. If no fault is found in the engine accessory drive system, the accessories themselves must be checked. See Step 4.
4. A noisy component can often be identified by probing with a stethoscope-type device while the engine is running at the problem speed. Removing the belt driving the suspect component will usually confirm the identification. If the problem source cannot be pinpointed by probing, a process of elimination is necessary. Remove accessory drive belts one at a time, checking for noise or vibration at the problem speed. When the condition disappears or diminishes, try a new belt on the component thus identified, since the belt construction irregularities may be present which won't show up on inspection. If belt changing doesn't help, repair or replace the noisy component. If the problem is found in the fan/water pump area, re-check for vibration with the fan removed, and if the condition improves, check the fan mounting surfaces for nicks or foreign matter that could cause fan run-out.

   If the source of the condition is not found in the engine accessory system, or corrected by the Tip-In Moan procedures, an imbalance condition in basic components is possible, though unlikely. These include crankshaft, vibration damper, flywheel or flexplate, and clutch or torque converter.

NOTE: Be sure the vibration condition observed in no-load testing occurs at the same engine speed registered on the tachometer during the road test. All engines have natural vibration frequencies which are evident at no-load, but no problem on the road.

Drive Axle Noise

1. **Gear noise** is the typical "howling" or "whining" of the ring gear and pinion due to an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.
2. **Chuckle** is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from approximately 64 km/h (40 mph) and usually can

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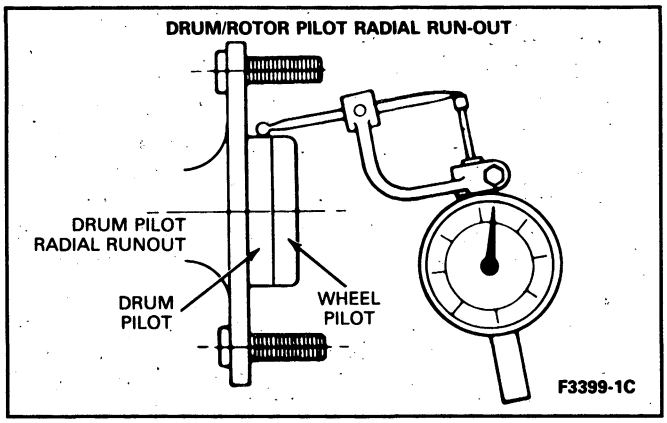


FIG. 3 Drum Rotor Pilot Radial Run-out

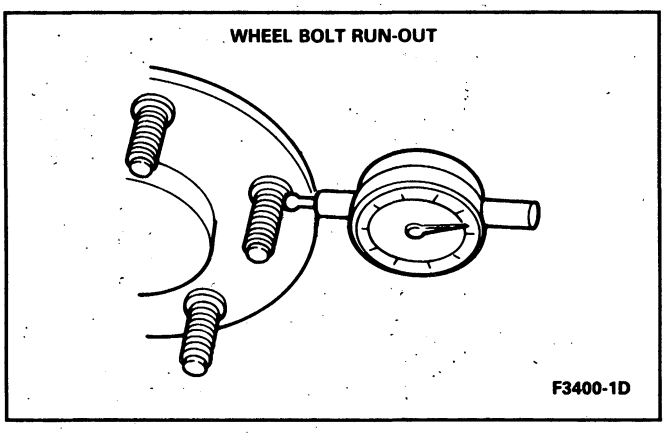


FIG. 4 Wheel Bolt Run-out

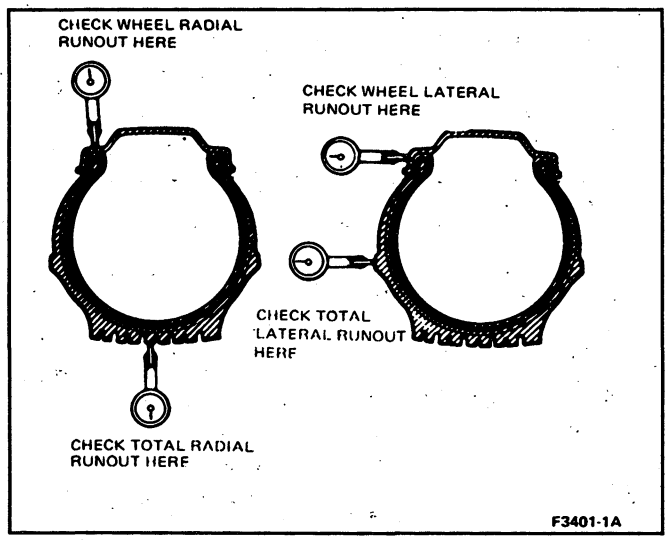


FIG. 5 Radial and Lateral Run-out

be heard all the way to a stop. The frequency varies with the speed of the vehicle.

3. **Knock** is very similar to chuckle; though it may be louder and occurs on acceleration or deceleration. The teardown will disclose what has to be corrected.

4. **Clunk** may be a metallic noise heard when the automatic transmission is engaged in Reverse or Drive, or it may occur when throttle is applied or released. It is caused by backlash somewhere in the driveline; it is "felt" or heard in the axle.

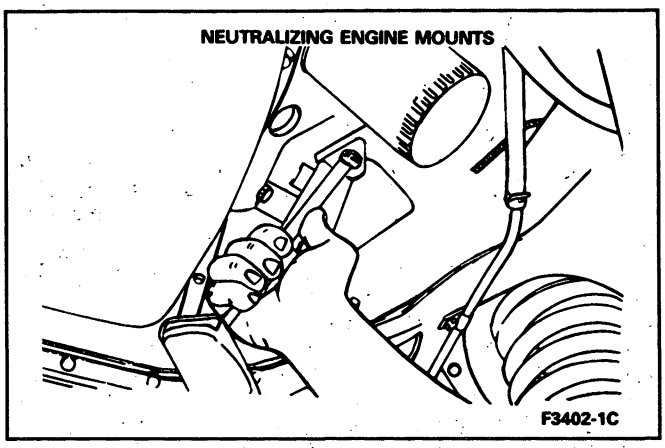


FIG. 6 Neutralizing Engine Mounts

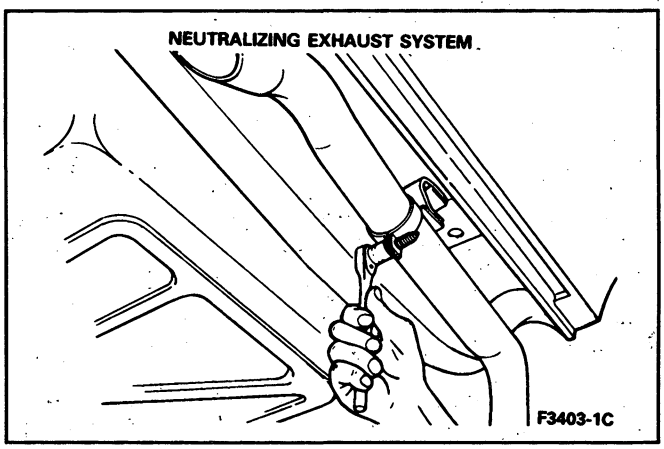


FIG. 7 Neutralizing Exhaust System

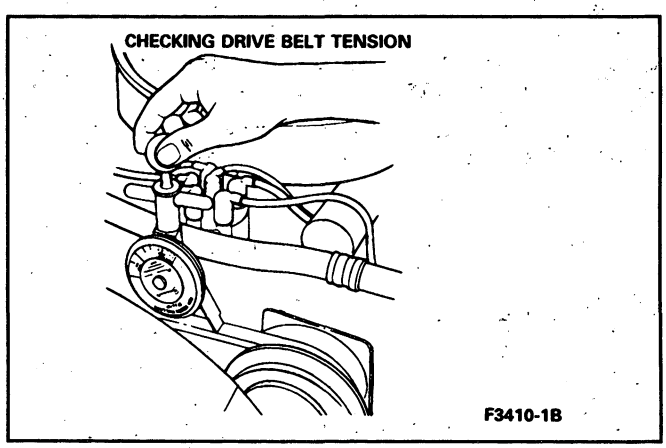


FIG. 8 Checking Drive Belt Tension

5. **Noise**

Bearing malfunctions normally will be obvious at disassembly (Fig. 12). As noted earlier, pinion bearings make a high pitched, whistling noise, usually at all speeds. However, if there is only one pinion bearing that is malfunctioning, the noise may vary in different driving phases.

Pinion bearings are frequently replaced unnecessarily when correcting gear noise. They should not be replaced unless they are

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actually scored or damaged, or there is a specific pinion bearing noise. Examine the large end of the rollers for wear. If the original blend radius has worn to a sharp edge, the bearing assembly should be replaced.

Wheel bearings might be mistaken for pinion bearings, so be sure to look at the wheel bearings carefully before tearing down the axle.

Some axle bearings are pressed into the housing, making it more difficult to check them. However, the axle shaft is the inner race for the bearing on semi-float type axles used on vehicles under 8500 lbs. G.V.W. So if the bearing is damaged, the roller surface on the shaft will be damaged as well (Fig. 13). The rollers can run on about the center of the polished surface.

6. **Bearing whine** is a high pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings, which are operating at driveshaft speed. Roller wheel bearings may whine the same way if they run completely dry. Bearing noise occurs at **all driving speeds;** this distinguishes it from gear whine, which usually comes and goes as speed changes.
7. **Bearing rumble** sounds like marbles being tumbled. This condition is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of driveshaft speed.
8. **Chatter on corners** is a condition where the whole rear end vibrates only when the vehicle is moving. The vibration is plainly felt as well as heard. In conventional axles, extra differential thrust washers cause a condition of partial lockup that creates this chatter. Chatter noise on limited slip axles can usually be traced to erratic movement between adjacent clutch components and can sometimes be corrected with a lubricant change and the addition of a friction modifier.
9. **Click at engagement** is a condition on axles of a slight noise, distinct from a "clunk," that happens in Reverse or Drive engagement. Check for the presence of a slinger.
10. **Axle shaft noise** is similar to gear noise and pinion bearing whine. However, axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed. If upon ride evaluation vehicle displays above noise condition, remove suspect axle shafts, replace wheel seals, and install a new set of axle shafts. Re-evaluate vehicle for noise before removing any internal components.

Non-Axle Noise

There are a few other conditions that can sound just like axle noise and have to be considered in pre-diagnosis. The four most common are exhaust, tires, roof racks and trim mouldings.

1. In certain conditions, the pitch of the exhaust may sound very much like gear whines. At other times, it can be mistaken for a wheel bearing rumble.
2. Tires, especially snow tires, can have a high-pitched tread whine or roar, similar to gear noise. Radial tires, to some degree, have this characteristic. Also, any non-standard tire with an unusual tread construction may emit a roar or whine type noise.
3. Trim and mouldings also can cause whistling or whining noise.

Therefore, be sure that none of these is the cause of the noise before proceeding with an axle teardown and diagnosis.

Analysis of Gear Noise

Gear Howl and Whine

When disassembling the axle to diagnosis and correct gear noise, it is assumed that the tires, exhaust, and trim items have first been checked as possible causes.

The noises described under "Road Test" usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are, of course, the type of noise heard on the road test and the driving conditions.

Chuckle

Chuckle that occurs on the driving phase is usually caused by excessive clearance due to differential gear wear; or by a damaged tooth on the coast side of the pinion or ring gear.

Any damage to a gear tooth on the coast side can cause a noise identical to chuckle. Even a very small tooth nick or ridge on the edge of a tooth is enough to cause the noise (Fig. 9).

You can often correct this condition and remove the noise simply by cleaning up the gear tooth nick or ridge with a small grinding wheel.

If either gear is damaged or scored badly, the gear set must be replaced. Also, if there is metal broken loose, the carrier and housing must be cleaned to remove particles that could cause damage later. Any other damaged parts in the axle must be replaced.

To check the gear set, remove as much lubricant as possible from the gears with clean solvent. Wipe the gears dry or blow them dry with compressed air. Look for scored or damaged teeth (Figs. 9 and 10). Also look for cracks or other damage.

If the cleaned up or damaged area is larger than 3.2mm (1/8 inch), it is advisable to replace the gear set.

Knock

Knock, which can occur in all driving phases, has several causes. In most cases, you will discover one of the following conditions:

1. A gear tooth damaged on the drive side is a common cause of the knock. This can usually be corrected by grinding the damaged area.
2. Occasionally, the ring gear bolts will knock against the inside of the carrier casting. The cause may be too little clearance, due to casting flash or bumps. In this case, the carrier can be removed and interference points ground out.

   Another possibility is simply that one or more bolts are slightly backed out. Proper tightening will correct the condition.
3. Knock is also characteristic of excessive end play in the axle shafts. Up to 0.254mm (0.010 inch) is allowed in most axles. However, it may be as high as 1.14mm (0.045 inch); so that knock occurs even in design conditions. The frequency of knock will

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be less because the axle shaft speed is slower than the driveshaft.

NOTE: Be sure to measure the end play with a dial indicator, not by feel. A "guesstimate" usually feels like far more end play than there actually is.

On the 8.8 inch axle, end play is allowable up to 0.762mm (0.030 inch), but can be reduced to 0.127mm (0.005 inch). It is controlled by the C-washer that holds the shaft in the pocket of the side gear (Fig. 11).

To reduce the clearance, cut a shim in the pattern of the washer and install it behind the washer. Do not reduce the end play to less than 0.127mm (0.005 inch).

Clunk

Clunk is due to backlash in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, make a check of the total axle backlash as follows:

1. Raise the vehicle on a frame or twin hoist so that the rear wheels are free.
2. Clamp a bar between the axle companion flange and a part of the frame or body so that the flange cannot move.
3. Lock the left rear wheel to keep it from turning.
4. Turn the right wheel slowly until you "feel" it in a drive condition. Hold a chalk marker on the side of the tire 12 inches from the center of the wheel.
5. Turn the wheel the other way until you again feel the drive condition.
6. Measure the length of the chalk mark, which is the total axle backlash. **It should be one inch or less.** If the backlash is within this limit, the clunk will not be eliminated by going into the axle.

Check for these conditions if the backlash is excessive:

1. Elongation of the differential pinion shaft holes in the differential case.
2. Missing differential or side gear washer.
3. Galling or excessive wear of the differential pinion shaft and bore.

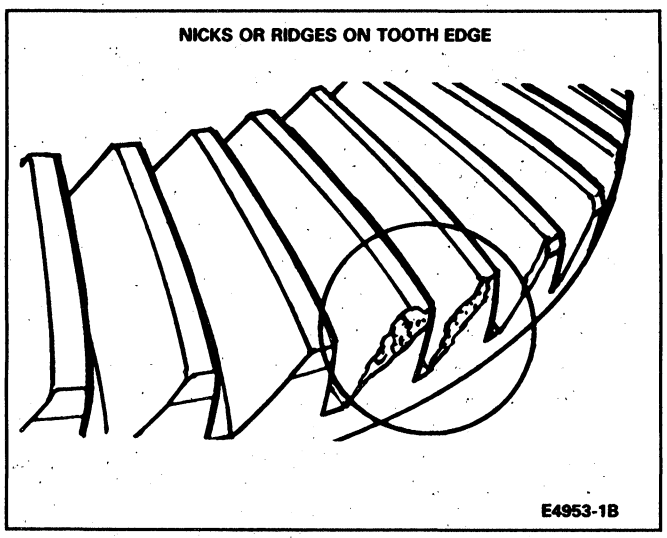


FIG. 9 Damaged Gear Tooth

If none of the above conditions shows up, there may be a loose fit of the axle shafts to the side gear splines. You should continue as follows **until the correction is made.**

4. Install new side gears and recheck the backlash.
5. Install two new axle shafts.
6. Replace the axle assembly.

Check Bearing Preload

The absence of differential bearing preload causes noise as driving loads tend to move the gear pattern to the outside (heel) of the ring gear. In fact, if the preload is not set right, it can move out to the edge and score and/or fatigue the gears.

Both the pinion bearing and differential bearing preload must be checked to be sure that the pattern will stay in place under load.

Check the pinion bearing preload by putting a N·m (in-lb) torque wrench on the pinion nut and measuring the torque effort it takes to turn the pinion (Fig. 14). Compare the reading with the preload specification for used bearings.

A tip about the pinion bearing preload: The pinion seal will offer a resistance equivalent to (0.5-4.0 in-lbs). If the bearings are preloaded, a reading higher than (0.5-4.0 in-lbs) on the torque wrench scale must be obtained. If not, there is no preload.

Another indication is some threads protruding from in front of the nut. Normally about 2.29-2.54mm (0.090-0.100 inch) of threads protrude if the preload is set properly. If the nut is flush with the end of the stem, chances are the preload was not set. See Pinion Bearing Preload Procedure for resetting the proper preload.

NOTE: The absence of preload here may indicate that the spacer between the pinion bearings on Ford axles is crushed and should be replaced.

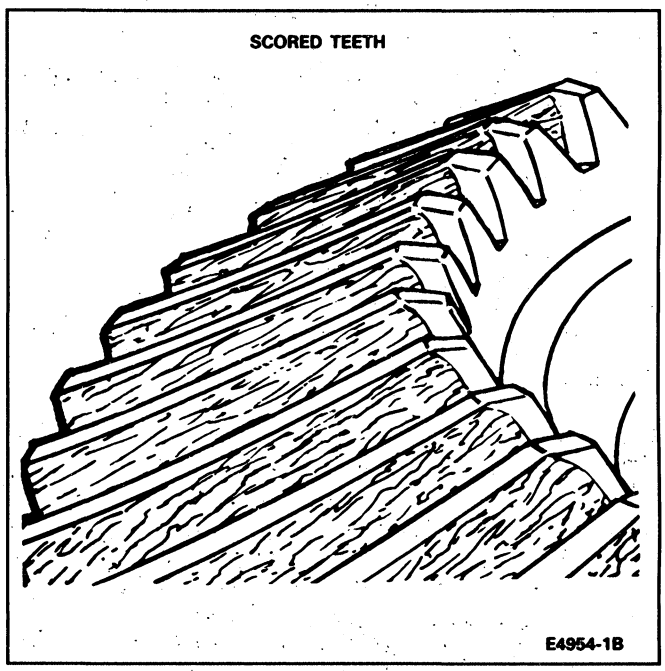


FIG. 10 Scored Gear Set

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ADJUSTMENTS AND SERVICE

Brake Drum Balancing

Rear brake drum imbalance can cause a vibration condition on light trucks that sometimes cannot be compensated for by wheel balancing.

If rear brake drum imbalance is suspected, raise the rear end of the vehicle, taking proper precautions. Remove the rear wheel and tire assembly.

Before testing, install all lug nuts with flat washers on them, to retain the drums to axle flanges. If drums do not have balance weights, run the vehicle up to the speed where vibration occurred during road test.

If the drums exhibit out-of-balance symptoms, they should be removed from the vehicle and balanced as follows:

1. Position the brake drum on a "bubble-type" balancer and noting the "heavy" side of the drum, place a wheel balance weight on the drum directly opposite the heavy point. Select the appropriate number of weights until the bubble balance indicates a "balanced" condition. Mark the location of the "light" side of the drum, and note the total amount of the balance weight needed to balance the drum.

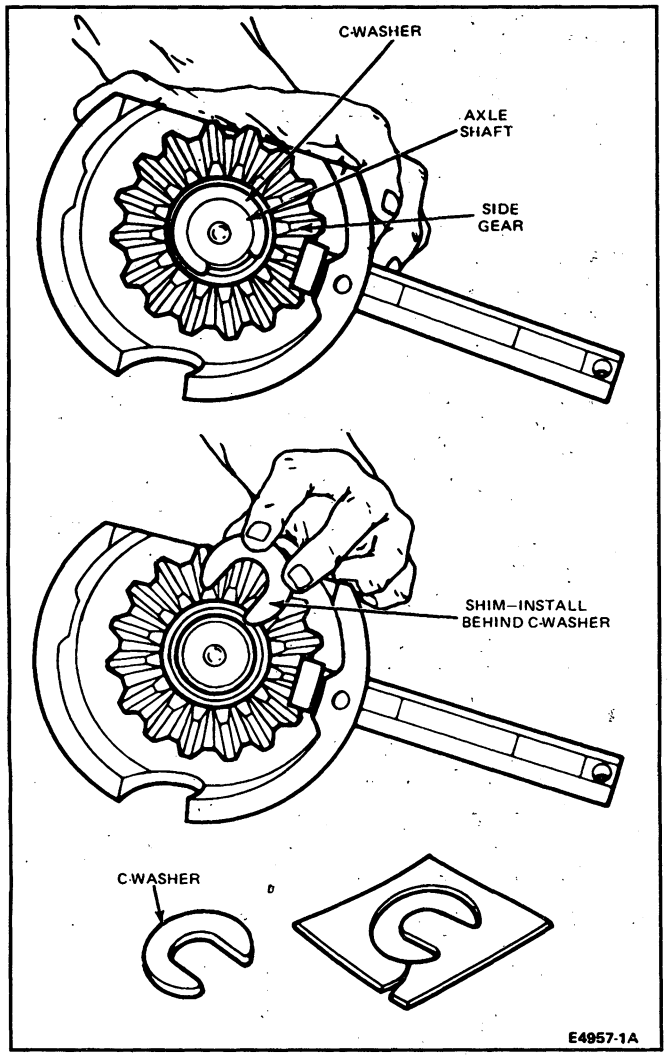


FIG. 11 Integral Axle End Play

NOTE: A drum which already has a balance weight attached, or requires less than 56.6 grams (2 oz.) of weight to balance, is not the prime cause of the vibration.

2. Fabricate a piece of mild steel to fit the curvature of the drum face and equal to the balance weights required to balance the brake drum (an old flywheel ring gear can be cut and used as a balance weight).

NOTE: A small postal scale may be used for determining the weight of both the balance weights used and the weight of the fabricated drum balance weight needed.

3. Position the drum balance weight on the drum face in the location on the light side of the drum indicated, as shown in Fig. 15. Arc weld (tachweld 6.35mm or 1/4 inch long) the balance weight to the drum face.

NOTE: Under no condition should any other welding method be used other than arc welding. To prevent drum distortion, do not use a current setting of more than 100 amps.

4. Install the balanced drum on the vehicle.
5. Static balance both rear wheels and tires and install on vehicle.
6. Road test to verify condition.

Driveshaft Balancing

For driveshaft balancing procedures, refer to Section 15-60, General Driveshaft Service.

GLOSSARY OF TERMS

Acceleration

1. **Light** —Increase in speed at less than 1/2 throttle.
2. **Heavy** —1/2 to full throttle increase in speed.
3. **WOT** —Wide open throttle.

Ambient Temperature

Surrounding or prevailing temperature. Normally, the temperature in the service area or outdoors, depending on where testing is taking place.

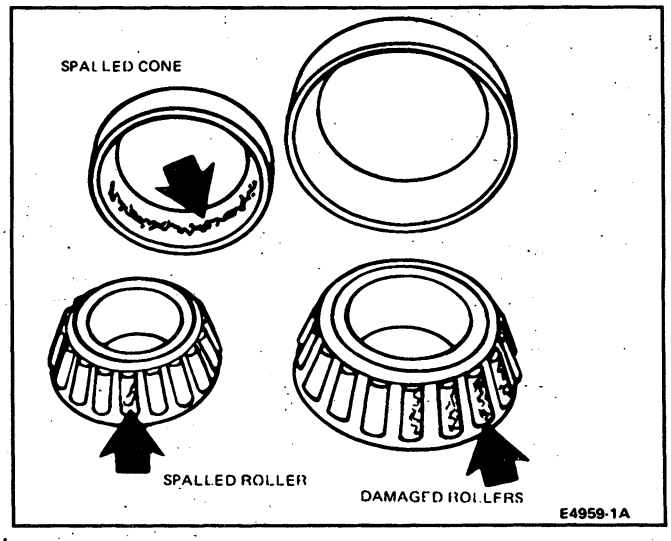


FIG. 12 Typical Bearing Malfunction

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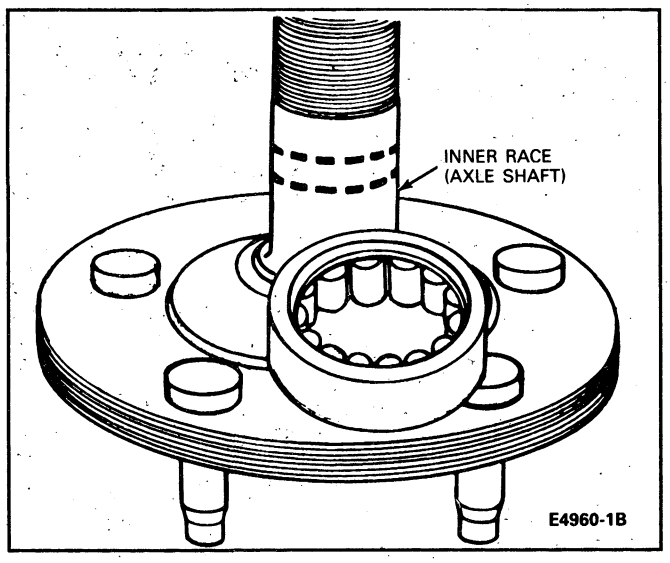


FIG. 13 Semi-Float Axle Wheel Bearing Inner Race

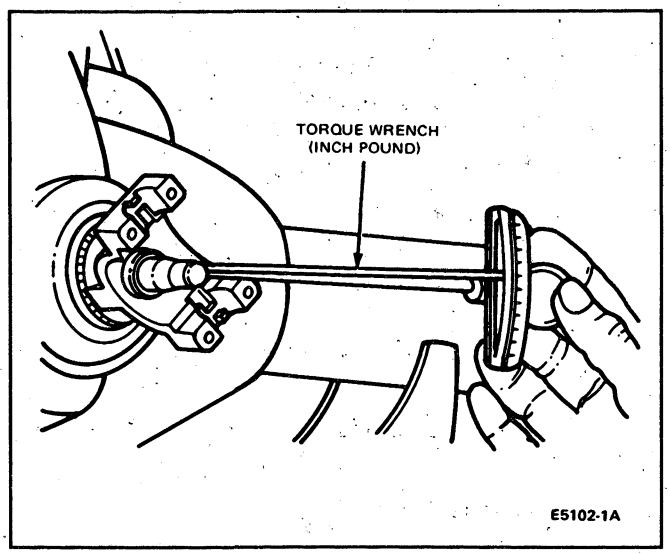


FIG. 14 Checking Pinion Bearing Preload

Articulation

Vertical movement of the front driving or rear axle relative to the frame of the vehicle to which they are attached.

Boom

A cycling, rhythmic noise often accompanied by sensation of pressure on the ear drums.

Bound Up

Refers to a stressed, rubber-mounted component that transmits any NVH which would normally be absorbed by the mount. (See Neutralize.)

Brakes Applied

When vehicle is stationary, service brakes applied with enough force to hold vehicle against acceleration with transmission in gear or drive.

Camber

Angle formed between front wheel spindle axis and horizontal as viewed from in front of the vehicle.

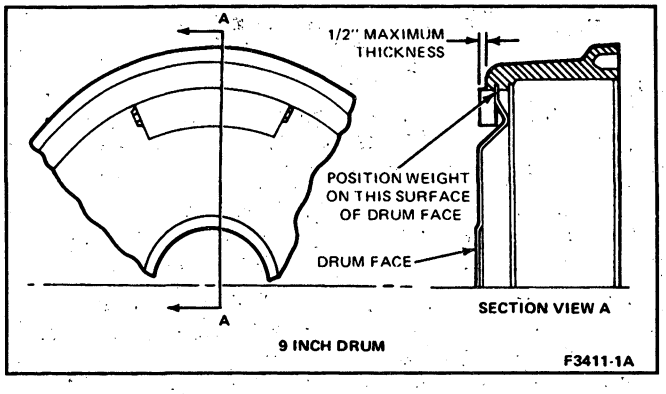


FIG. 15 Brake Drum Balance

Caster

Angle formed between the kingpin axis and a vertical axis as viewed from the side of the vehicle. Caster is considered positive when the top of the kingpin axis is behind the vertical axis.

Coast/Neutral Coast

Engine/transmission taken out of gear with driveshaft/driveline by placing transmission selector in Neutral or by depressing clutch (manual transmission).

CPS

Cycle Per Second.

Cruise

Steady highway speed, neither accelerating nor decelerating; even pressure on accelerator pedal on level ground.

Controlled Rear Suspension Height

The height at which the components of a particular vehicle should be set when driveline angle measurements are made.

Deceleration

Slowing of vehicle by releasing foot from accelerator at cruise and allowing engine to slow vehicle without application of brakes.

Driveline Angle

Alignment of the transmission output shaft, driveshaft, and rear axle pinion centerline.

Driveshaft (Propeller Shaft/Propshaft)

Rearmost shaft of a driveline which powers the rear axle input shaft (pinion shaft).

Drivetrain

Includes all power transmitting components from the engine to the wheels, including clutch/torque converter, transmission, transfer case, driveline and front or rear drive axles.

Engine Run-Up Test

Operation of engine through normal RPM range with vehicle sitting still, transmission in Neutral. Used for engine and accessory vibration check.

Engine Misfire

One or more cylinders in the engine fails to fire at the proper time.

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Extension Housing Damper

A counterweight attached to an arm on the rear of the transmission extension housing and designed to "soak up" or dampen unwanted driveline or powertrain vibrations.

Engine Imbalance

Some component in the engine which is normally smoothly balanced now causing a perceptible vibration in the vehicle.

Flat Spots (Tires)

Commonly caused by letting vehicle stand while tires cool off. Can be cured by again operating vehicle until tires are warm. Also, regular tire wear patterns in the tire tread resulting from wheel-locked skids.

Float

A cruising drive mode in which throttle setting matches engine speed to road speed, neither accelerating or decelerating.

Gravelly Feel

A grinding or growl in a component, similar to the feel experienced while driving on gravel.

Harshness

A harder than usual behavior of a component, like riding a vehicle with over-inflated tires.

Hz

Hertz (Cycles Per Second).

Imbalance (or Unbalance)

Out of balance; more weight on one side of a rotating component causing shake or vibration.

Inboard

Toward the centerline of the vehicle. (See Outboard.)

Isolate

Separate from the influence of other components.

NVH

Noise, Vibration, Harshness.

Neutralize (Normalize)

To return to unstressed position. Used to describe various mounts and exhaust system hangers (see Bound Up).

Outboard

Toward the outside of the vehicle, rather than toward the centerline (see Inboard).

Pinion Shaft

The input shaft to a driving axle, usually a part of the smaller driving or input gear of a "Ring and Pinion" gear set.

Pumping Feel

A very slow vibration that results in a movement of vehicle components, similar to pumping the service brakes slightly.

Radial/Lateral

Radial is in the plane of rotation, lateral is at 90 degrees to the plane of rotation.

Ring Gear

The large gear, driven by the pinion gear of a "Ring and Pinion" driving axle gear set. Not applicable to transaxle.

Road Test

Operation of vehicle under conditions designed to recreate the problem condition.

Run-out

Out of round or wobble.

Shake

Low frequency vibration, usually results in visual movement of components.

Slip Yoke (Slip Spline)

Driveshaft coupling device (1/2 of a U-Joint) which compensates for changes in shaft length due to articulation of axle; used at one end of driveshaft.

Tire Force Vibration

Tire vibration caused by variations in the construction of the tire, resulting in a vibration when the tire rotates against the pavement. This condition may be present on perfectly round tires because of variations in the inner construction.

Two-Plane Balance

Radial and lateral balance.

Tire Deflection

Bending of the body of the tire during rotation.

T.I.R.

Total indicated Run-out.

Tip-In Moan

A light moaning noise heard when the vehicle is lightly accelerated, usually between 40-104 km/h (25-65 mph).

Vibration

Regular movement of a component that results in a sound or feel of movement.

SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS

Number	Description
Tool-4201-C	Dial Indicator with Bracketry
T68P-4602-A	Pinion Angle Level Gauge
T63L-8620-A	Belt Tension Gauge

CF3412-1B

ROTUNDA EQUIPMENT

Number	Description
006-01399	Strobe Light Balancer
007-00014	Radial Run-out Gauge

CF4596-1B

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GROUP 19

ROADABILITY

SECTION 19-01 Roadability

SUBJECT	PAGE
ADJUSTMENTS	
Caster Split Adjustment	19-01-4
Centering Steering Wheel (Clear Vision)	19-01-2
Diagnosis Guides	19-01-5
Front Wheel Alignment	19-01-3
Steering Gear Adjustments	19-01-3
Wheel Bearing Adjustment	19-01-4
DESCRIPTION	19-01-1
DIAGNOSIS AND TESTING	
Steering—Drift/Pull	19-01-2
INSPECTION	
Attachments and Fasteners	19-01-14
Brake Drag	19-01-14
Improper Loading	19-01-4
Match Mounting Tires	19-01-10
Radius Arm Bushing	19-01-14

SUBJECT	PAGE
INSPECTION (Cont'd)	
Shock Absorber Checks	19-01-12
Spindle Rotating Torque	19-01-13
Tire Circumference Variation	19-01-11
Tire Conicity	19-01-10
Tire Imbalance	19-01-10
Off-Vehicle Balancing	19-01-10
Tire and Wheel Balance	19-01-10
Tire Non-Uniformity	19-01-9
Tire and Wheel Runout	19-01-9
Tire Runout	19-01-10
Tire/Wheel Size and Inflation Pressure	19-01-6
Wheelbase Mismatch	19-01-12
SPECIAL SERVICE TOOLS	19-01-14
VEHICLE APPLICATION	19-01-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 (4x2/4x4), F-Super Duty and Bronco Vehicles.

DESCRIPTION

Roadability describes the vehicle's capability to handle the road. The feel of the road is transmitted to the driver through the suspension, steering, and wheel and tire components.

The following conditions are related to roadability concerns:

- Wander—Wander is the tendency of the vehicle to require steering wheel corrections to maintain a straight path down the road. The vehicle deviates to the left and/or right in a cyclic or random manner when driven on a flat pavement.
- Shimmy—Shimmy is a consistent side-to-side wobble in the steering wheel or the road wheels. The shimmy is usually felt over 64 km/h (40 mph), which is amplified when the tire contacts pot holes or bumps in the road surface.
- Steering Binding (Sticky)—When the steering is binding or sticky, the tendency of the vehicle is not to return to the desired straight ahead direction after any steering wheel input of 20 degrees (1/16 turn of the steering wheel) or more. A vehicle with this condition will require centering of the steering wheel by the driver, after a sharp turn, rather than return by itself due to road force at the tire.
- Groove Feel (Small Angle Returnability)—Groove feel describes the characteristic 'feel' of the steering system during straight ahead highway driving. Small steering deviations from the straight ahead position are counteracted by forces tending to return the steering system and wheel to the centered straight ahead position. A vehicle with poor groove feel may continuously require small steering corrections to maintain a desired straight ahead path.
- Drift/Pull—A drift or pull condition will cause a vehicle to deviate from a straight ahead direction in the absence of any steering input. Drift/pull may be induced by conditions external to the vehicle (i.e., wind, road camber). However, a vehicle related drift/pull, on a flat road, will cause a consistent deviation

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from the straight ahead path and require constant steering input in the opposite direction to counteract the effect.

- Clear Vision Error—When driven on a flat pavement, the vehicle follows a straight line, however, the steering wheel is not level or centered.

DIAGNOSIS AND TESTING

Refer to the diagnosis chart for a diagnosis of conditions, possible causes and resolution. Refer to the diagnosis guide in this Section for a roadability diagnosis procedure.

Steering—Drift/Pull

Drift/pull type conditions may be caused by improper torque and tightening sequence of the steering linkage. BECAUSE THE RUBBER BALL SOCKET LINKAGE TENDS TO RETURN TO ITS INSTALLED POSITION, IT IS IMPERATIVE THAT THE INSTALLATION BE ACCOMPLISHED WITH THE FRONT WHEELS AND THE PITMAN ARM IN THE STRAIGHT AHEAD POSITION, AND THE STUD SEATED IN THE TAPERED HOLE PRIOR TO TIGHTENING THE NUTS. Care should be taken with the installation to prevent a possible drift condition.

To diagnose if a preload in the rubber is causing the drift, the following procedure is recommended:

1. Loosen the studs in the tapered holes at the pitman arm and the left and right spindles (i.e., disengage the stud from the hole so that it is no longer seated).
2. Hand install the nuts so that the stud is free to turn inside the tapered hole.
3. INSTALL COTTER PINS IN ALL THE STUDS.
4. Drive the vehicle. If it no longer drifts, then it can be assumed that the rubber was causing the drift. If it continues to drift, the condition is NOT being caused by the rubber ball sockets.
5. In either case, do not replace the steering linkage.

Reinstall the linkage as described in the following procedures.

F-150—F-350, F-Super Duty and Bronco

1. Ensure the pitman arm and wheels are in the straight ahead position. (The pitman arm is exactly straight ahead when the clear vision is at 0 degrees except on F-350 4x4 and F-Super Duty).
2. Lock the steering wheel in the straight ahead position and loosely assemble the steering linkage to the pitman arm and then to the spindles.
3. Being careful not to change the position of the pitman arm, tighten the steering linkage nuts to 88 N·m (65 ft-lbs). The recommended sequence for tightening is: 1) the pitman arm, 2) the right side spindle and 3) the left side spindle.
4. Install all the cotter pins by advancing the nut to the next castellation.
5. Adjust the toe-in if necessary.

E-150—E-350

1. Ensure that the wheels are in the straight ahead position.

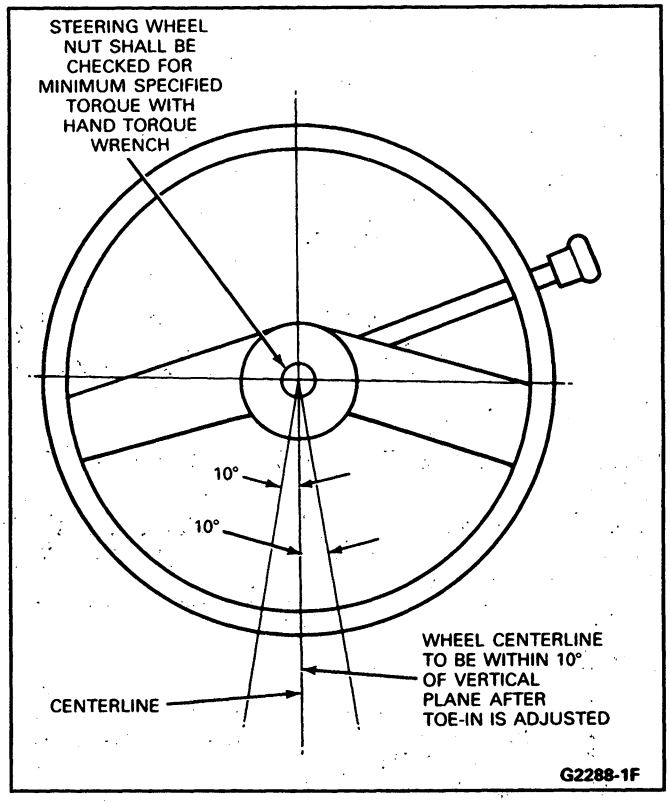


FIG. 1 Acceptable Steering Wheel Installation—Measured From Normal Spoke Angle

2. Lock the steering wheel in the straight ahead position and loosely assemble the steering linkage to the spindles and the pitman arm.
3. Being careful not to move the wheels from the straight ahead position, tighten the steering linkage nuts to 88 N·m (65 ft-lbs). The recommended tightening sequence is: 1) the right side spindle, 2) the pitman arm and 3) the left side spindle.
4. Install all the cotter pins by advancing the nut to the next castellation.
5. Adjust the toe-in and reset the clear vision if necessary.

ADJUSTMENTS

Centering Steering Wheel (Clear Vision)

F-150—F-350, F-Super Duty and Bronco

Steering wheel clear vision (Fig. 1) is preset at vehicle assembly prior to toe-adjustment and cannot be adjusted by removing the steering wheel and mis-indexing the steering wheel and steering shaft alignment marks (Fig. 3).

NOTE: Whenever original nut is removed, it should be replaced with a new 382412-S2 or 389530-S2 nut and tightened to 41-56 N·m (30-42 ft-lb), or equivalent.

After verification of correct assembly, as noted below, toe must be readjusted to resolve a clear vision complaint. Toe adjustment is similar to passenger car utilizing dual toe adjuster sleeves. The following steering system components should be inspected:

- Steering column U-joint alignment notch is at 12 O'clock when steering wheel is in straight ahead position (refer to Fig. 4).

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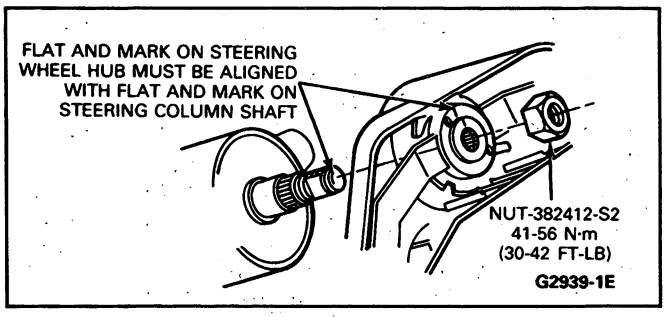


FIG. 2 Steering Wheel Installation Econoline

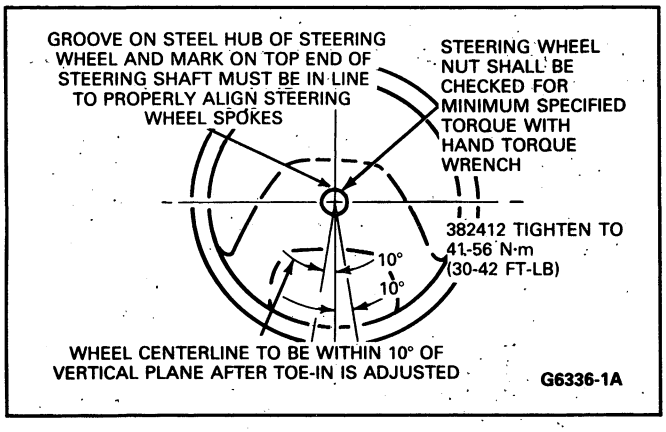


FIG. 3 Steering Wheel Installation—F-Series

- Clearances are equal (approx. 4.06mm or 0.16 inch) from both large and small diameter flex coupling pins to intermediate shaft flange cutouts.

If inspection of the above components indicates correct installation of steering components, resolve the clear vision complaint by re-adjusting toe as described in Section 14-01, General Suspension Service.

If inspection of the above components indicate incorrect installation, remove, re-index, or correct any improper installation as suggested in the following procedures:

U-Joint Alignment Notch Is Not At 12 O'Clock When Steering Wheel Straight Ahead (Fig. 4)

1. Remove the two screws from the underside of each steering wheel spoke and lift the horn switch (pad) from the wheel.
2. Check to see that the mark on the steering shaft and the mark on the wheel hub are aligned (Fig. 2).
3. If the marks do not align, remove the wheel and re-install as described in this Section in the Removal and Installation Section.

Final Toe Check

After completing the above checks, center the steering wheel. The front wheels should still be in the straight ahead position and the toe adjusted properly. If required, adjust toe per Section 14-01, General Suspension Service.

E-150—E-350

1. Set wheels in straight ahead position by driving vehicle a short distance and mark the steering wheel and steering column relationship with a chalk mark.

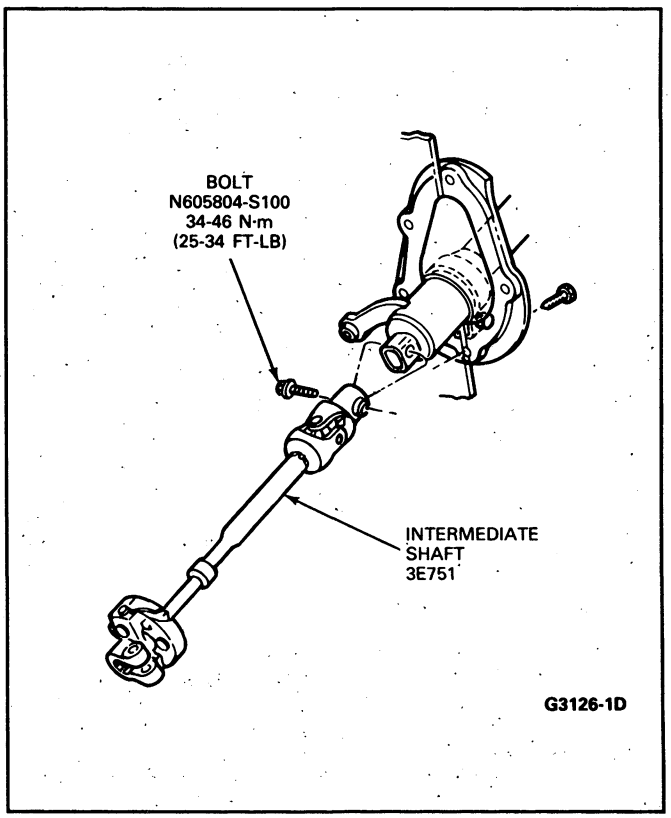


FIG. 4 Steering Column Alignment—Typical

2. Note the steering wheel position with toe adjusted on E-Series, if off center (spokes in horizontal position) more than plus or minus 10 degrees in a vertical plane (Fig. 1), remove the steering wheel as described in this Section.
3. Install the steering wheel on the steering column so that the steering wheel is within 10 degrees plus or minus from horizontal.
4. Position steering wheel into place with retaining nut.
5. Tighten retaining nut to 41-57 N·m (30-42 ft-lbs).
6. Connect the spade terminal of the horn switch wire to the blade connector, and press the "J" clip ground terminal fully into the threaded hole.
7. Center the horn switch (pad) on the steering wheel, and install the two attaching screws.

Steering Gear Adjustments

Manual Steering Gear

For mesh load and preload adjustments, refer to Section 13-35, Manual Steering Gear—Recirculating Ball (Koyo) under Adjustments.

Power Steering Gear

For meshload adjustments and rotary valve centering checks, refer to Section 13-41, Integral Power Steering Gear—Ford under Adjustments.

Front Wheel Alignment

For a detailed description of caster, camber and toe adjustment procedures relating to front wheel alignment and specifications, refer to Section 14-01, General Suspension Service.

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Caster Split Adjustment

The specified maximum caster split is 1.5 degrees. However, a difference in side-to side caster angles, or split, of more than 3/4 degree may cause some vehicles to drift or pull toward the side with less caster.

Caster may be adjusted using one of three service adjusters to increase the caster angle up to 1-1/2 degrees on either wheel to correct the split. The installation procedure is described in Section 14-01, General Suspension Service. Any caster adjustment should result in equal caster between both wheels for a level vehicle either at curb weight or at the loaded condition that the vehicle operates at for most of its use.

NOTE: Several factors influence a vehicle's tendency to drift or pull. These factors are listed under drift/pull in the roadability diagnosis chart in the diagnosis guides portion of this Section. All related possible causes for the drift/pull other than excessive caster split should be verified and resolved as required before caster split correction is attempted.

F-150—F-350 (4x2)

Caster can be adjusted by replacing the caster/camber adjuster, or slug, found at the upper spindle-to-axle joint. A zero degree adjuster is installed in production. Replacement adjusters can be ordered through service to either increase or decrease caster up to 1-1/2 degrees in 1/2 degree increments. Refer to Section 14-01, General Suspension Service, for description of their use and installation.

F-150 (4x4) and Bronco

Caster is not adjustable on F-150 (4x4) and Bronco trucks.

E-150—E-350

A service kit (Part Number E5TZ-3K064-A) is available which includes complete instructions for increasing caster in increments of 1/2 degree.

F-250—F-350 (4x4) and F-Super Duty

The caster angle on the F-250—F-350 (4x4), and F-Super Duty with a leaf spring type front suspension can be adjusted by inserting a shim between the spring and axle. Shims are available in 0 degree, 1 degree and 2 degree increments. The 0 degree shim is used to adjust side to side ride height when an angled shim is installed on the opposite side of the front axle.

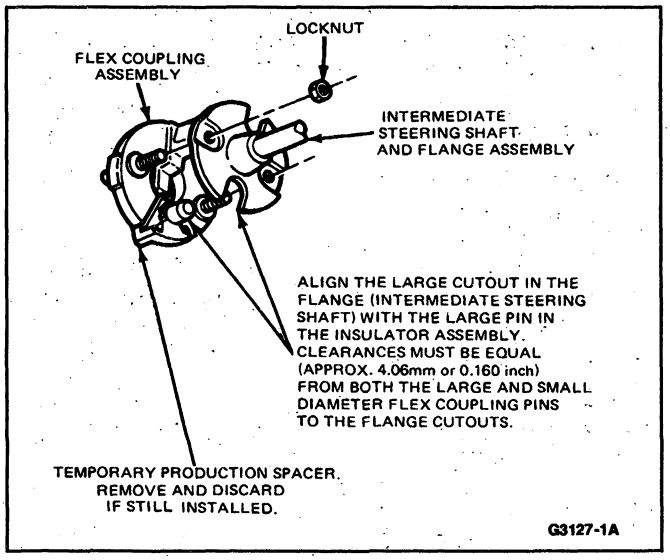


FIG. 5 Flex-Coupling to Intermediate Shaft Alignment E-150—E-350

NOTE: On F-250 (4x4) vehicles equipped with dual axle arm front drive axles, a shim can be installed on one side only to reduce side-to-side caster split. On F-350 (4x4) and F-Super Duty vehicles equipped with Dana Monobeam front drive axles, install a shim on each side of the axle tube. On these vehicles side-to-side caster split cannot be reduced.

1. To adjust caster, raise the vehicle and support the front axles on safety stands.

NOTE: If possible, caster adjustment should always be done on the right front axle to avoid changing front driveshaft alignment.

2. Loosen U-bolt nuts and separate spring from axle. Install caster shims between spring and axle. Position the thin edge of the shim towards the front of the vehicle to increase caster, thin edge to the rear to decrease caster.

NOTE: Caster shims installed on the LH axle will change the front driveshaft angle. If a caster shim is used on the LH axle, driveshaft angles must be checked and conform to specifications in Section 15-60 Driveshaft—Single Type U-Joint. Always attempt to correct side-to-side caster variations by adjusting the RH axle caster.

Tighten U-bolt nuts until all nuts contact cap. Tighten nuts to 142 N·m (105 ft-lbs).

Wheel Bearing Adjustment

For wheel bearing adjustment procedures, refer to the Adjustment portion of Section 11-10, Wheel Hubs and Bearings—Front (except Front Drive) for 4x2 vehicles and Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive for 4x4 vehicles.

INSPECTION

Improper Loading

The vehicle's load capacity is designated by weight, not volume. Thus, with large or heavy loads, you cannot necessarily load the vehicle until all available space is full. Maximum safe vehicle weights (front, rear and total), as well as tire and rim sizes and inflation pressures, are specified for each truck on the Safety Standard Certification Label on the driver's door rear pillar. A sample Safety Standard Certification Label with typical example numbers and an explanation of how this information should be used can be found in Section 10-00, Identification Codes.

NOTE: Do not use the sample numbers on the Safety Standard Certification Label shown. Use the actual numbers that appear on the vehicle.

NOTE: The Vehicle Identification Number is listed on the Safety Standard Certification Label and is the same as the warranty number.

GVWR (Gross Vehicle Weight Rating)—The maximum loaded weight at which the vehicle is to be operated.

GAWR (Gross Axle Weight Rating)—The maximum loaded weight of each axle measured at the ground. These ratings are attainable only with the tires inflated to the specified pressures. The use of selected heavier

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Diagnosis Guides

ROADABILITY DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	RESOLUTION
Wander	1. Improper loading.	1. Weigh vehicle. Redistribute load.
	2. Improper tire/wheel size.	2. Replace as necessary.
	3. Improper tire pressure.	3. Inflate to specification.
	4. Steering gear not centered.	4. Index steering wheel to column, if required, center steering wheel by adjusting tie rod adjusting sleeve.
	5. Steering gear preload/meshload adjustment off.	5. Measure/adjust preload/meshload.
	6. Incorrect wheel alignment.	6. Align front end.
	7. Excessive spindle rotating torques.	7. Service ball joints or kingpins.
	8. Steering linkage ball studs sloppy or sticky.	8. Inspect and service.
Shimmy	1. Improper wheels/tires.	1. Replace as required.
	2. Incorrect tire pressure.	2. Inflate to specification.
	3. Tire non-uniformity.	3. Check runouts of tires & wheels.
	4. Tire imbalance.	4. Rebalance assemblies static/dynamic.
	5. Loose wheel bearings.	5. Check & adjust per procedure.
	6. Steering gear preload/meshload low.	6. Check & adjust.
	7. Steering linkage ball stud looseness.	7. Inspect and service.
	8. Loose suspension attachments & components.	8. Inspect **all** attachments and check bushings for wear.
	9. Worn radius arm bushings.	9. Inspect and replace radius arm bushings if required.
	10. Weak shock absorber control.	10. Service shocks as required.
Steering Binding (Sticky) or Poor Groove Feel (Small Angle Returnability)	1. High spindle rotating torque.	1. Inspect & service.
	2. High steering linkage ball stud turning torques.	2. Inspect and service.
	3. Incorrect front wheel toe set (poor groove feel mainly).	3. Measure & reset toe in.
	4. Excessive steering gear preload/meshload.	4. Measure & adjust meshload/preload.
	5. Power steering control valve centering.	5. Inspect & service.
Drift/Pull	1. Improper loading creating caster split. (Side to side).	1. Measure alignment & service as required. Weigh vehicle.
	2. Mismatched tires/wheels.	2. Service as required.
	3. Tire pressure.	3. Inflate to specification.
	4. Tire conicity.	4. Service through tire rotation.
	5. Unequal tire circumferences.	5. Measure & service.
	6. Excessive caster split.	6. Balance caster split.
	7. Improper toe set.	7. Measure and reset toe in.
	8. Front wheel brake drag.	8. Check during alignment inspection.
	9. Power steering control valve centering.	9. Check steering gear valve centering.
	10. Wheel base mismatch.	10. Check per procedure under Inspection portion in this Section.
Clear Vision Error	F-150-F-350, F-Super Duty and Bronco 1. Incorrect toe setting.	1. Set to specification per the appropriate Section in Group 14.
	E-150-E-350 1. Incorrect toe setting.	1. Set to specification per the appropriate Section in Group 14.
	2. Steering wheel incorrectly positioned on steering shaft.	2. Set wheel to specification per this Section.

CF3716-2F

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ROADABILITY DIAGNOSIS GUIDE

TEST STEP			
1.0	PRELIMINARY INSPECTION		
	After conducting a road test to identify the particular roadability condition, perform the preliminary inspection listed below. Correct any conditions not up to specifications or requirements. ① Check tire pressure. Adjust tire pressure as specified on the Safety Standard Certification Label. ② Check tire/wheel size. All tires must be the same size. Refer to the Safety Standard Certification Label found on the vehicle for the specified sizes. ③ Check the tire wear pattern to identify a possible out-of-alignment condition. ④ Check front tires for radial runout and flat spots. ⑤ Inspect for overloading or improper load distribution. ⑥ Check power steering pump for low fluid or severe aeration. ⑦ Check steering linkage for excessive binding or free play. ⑧ Remove the wheel and tire, and disconnect the steering linkage from the spindle. Rotate the spindle back and forth ten (10) times to verify free movement. Use a dial indicator type torque wrench on the bottom ball stud nut. Rotate the spindle from stop to stop slowly and read the maximum torque to rotate. Rotational torque should not exceed 20 N•m (15 ft-lbs). ⑨ Check spindle end play. Connect linkage and install wheel and tire. ⑩ Inspect components for looseness or damage. ⑪ Road test vehicle to determine possible causal area. Follow test procedure.		
2.0	ROAD TEST	RESULT	ACTION TO TAKE
	• Road test the vehicle (after proper corrections are performed after preliminary inspection) and identify the particular Roadability condition.	Wander Condition ▶	GO to **3.**
		Drift/Pull Condition ▶	GO to **6.**
		Steering Binding — Poor Wheel Return ▶	GO to **5.**
		Lack of "Groove" Feel — Poor Center Feel ▶	GO to **5.**
		Steering or Suspension Shimmy ▶	GO to **4.**

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suspension components (such as after-market installations) does not necessarily increase the GVWR or GAWRs.

NOTE: The vehicle cannot be loaded to both the front and rear GAWR, since the GVWR will be exceeded.

The total weight for the example vehicle (not yours) must not exceed 3538 kg (7800 lbs.) with the front tires inflated to 241 kPa (35 psi) cold, and the rear tires inflated to 517 kPa (75 psi) cold. This includes full fuel tank(s), vehicle equipment, and occupants (driver and passengers), as well as the cargo load. **NOTE THAT THE DRIVER AND PASSENGERS ARE PART OF THE VEHICLE LOAD.**

Due to the variety of engines, axles and accessories available on Ford trucks, each vehicle is subject to different maximum load weights. If you suspect that payload is excessive, weigh the vehicle by axle at a highway weigh station or appropriate commercial facility. Weigh the total vehicle, then separately weigh the vehicle at the front and rear wheels. The GVWR and GAWRs should not be exceeded. To assure proper vehicle handling, the load should also be balanced from side to side.

Tire/Wheel Size and Inflation Pressure

Information regarding tires, wheels and recommended inflation pressures for each vehicle as manufactured is included with every vehicle. Vehicles completed by Ford will have the information included on the Safety Standard Certification Label on the driver's door lock pillar. On vehicles completed by a second stage manufacturer, the information will be included on their certification documentation.

All available tire and wheel combinations used in production are listed in the shop manual along with recommended pressures for specific gross vehicle weights. Variance from released configuration can be a source of numerous concerns (ride, wander, shimmy, tire life, speedometer accuracy, etc.).

- Replace non-matching tires.
- Inflate all tires to specification.

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

	TEST STEP	RESULT	ACTION TO TAKE
3	WANDER		
	Steering Wheel Alignment — Remove the horn pad from steering wheel and check that the notch on the steering column shaft aligns with the steering wheel. Check pot joint alignment per "centering steering wheel" under adjustments.	Steering wheel and steering shaft in alignment (OK) ▶	GO to **3A**.
		Steering wheel or steering shaft not aligned (OK) ▶	ALIGN steering wheel and shaft as described in Centering Steering Wheel under Adjustments in this Section.
3A	WHEEL ALIGNMENT		
	Check the front alignment to be within specifications.	Within specifications (OK) ▶	GO to **3B**.
		Not within specifications (OK) ▶	CORRECT the alignment as described in Wheel Alignment under Adjustments in this Section.
3B	SPINDLE ROTATION		
	Rotate the spindle and check for stiffness, binding or excessive spindle rotational torque. (If not checked during 1.0, preliminary inspection.)	Within specifications (OK) ▶	GO to **3C**.
		Spindle stiff, binding or hard to rotate (OK) ▶	REFER to Spindle Rotational Torque in this Section. If still not OK REMOVE and REPLACE ball joints.
3C	STEERING GEAR CHECK		
	Check the steering gear (manual and power) meshload and preload.	Meshload and/or preload not to specification (OK) ▶	ADJUST meshload and/or preload as described in the appropriate Steering Gear Section in this manual.
4	SHIMMY		
	Check tires for signs of imbalance.	Tires in balance (OK) ▶	GO to **4A**.
		Tires out of balance (OK) ▶	RE-BALANCE tires.
4A	TIRE RUNOUT CHECK		
	Check tire assemblies for excessive runout.	Runout less than 1 mm (.040 inch) (OK) ▶	GO to **4B**.
		Runout greater than 1 mm (.040 inch) (OK) ▶	REFER to Match Mounting Information described under INSPECTION in this Section.
4B	SHOCK ABSORBER CHECK		
	Check shock absorber for signs of leakage. Bounce front of vehicle to check for excessive bouncing.	No leakage or excessive bouncing (OK) ▶	GO to **4C**.
		Shocks leak and/or bounce excessively (OK) ▶	REMOVE and REPLACE shock absorbers.

CF3717-2C

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT	ACTION TO TAKE
4C	WHEEL BEARING CHECK		
	Check wheel bearings for looseness, out-of-adjustment, improper lubrication, wear or damage.	Wheel bearings (OK) ▶	GO to **4D**.
		Wheel bearings (OK) ▶	ADJUST, REPAIR, or REPLACE wheel bearings as required.
4D	STEERING GEAR CHECK		
	Check the steering gear (manual and power) meshload and preload.	Meshload and/or preload up to specified level (OK) ▶	GO to **4E**.
		Meshload and/or preload not up to specified level (OK) ▶	ADJUST meshload and/or preload as described in the appropriate Steering Gear Section in this manual.
4E	STEERING LINKAGE CHECK		
	Check the steering linkage for looseness.	Steering linkage (OK) ▶	GO to **4F**.
		Steering linkage loose (OK) ▶	REPLACE steering linkage.
4F	SUSPENSION SYSTEM TORQUES		
	Check for looseness and proper torque with suspension attachments and components.	Suspension system up to specifications (OK) ▶	GO to **4G**.
		Suspension attachments and components loose (OK) ▶	TIGHTEN suspension attachments and components to specification.
4G	RADIUS ARM BUSHINGS		
	Visually inspect the radius arm bushings for wear or damage.	Bushings worn or damaged (OK) ▶	REMOVE and REPLACE bushings.
5	STEERING BINDING OR GROOVE FEEL		
	Remove the horn pad and check the steering wheel alignment. The notch on the steering column shaft must align with the mark on the steering wheel.	Marks in alignment (OK) ▶	GO to **5A**.
		Marks not aligned (OK) ▶	ALIGN steering wheel and shaft as described in Centering Steering Wheel under Adjustments in this Section.

CF3718-2C

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT	ACTION TO TAKE
5A	STEERING GEAR		
	Check steering gear (manual and power) for excessive meshload and/or preload.	Meshload and/or preload at specifications (OK) ▶	GO to **5B**.
		Meshload and/or preload not at specifications (OK) ▶	ADJUST preload and/or meshload as described in the appropriate steering gear section in this manual.
5B	STEERING LINKAGE		
	Check the steering linkage ball studs for stiffness or looseness.	Steering linkage (OK) ▶	GO to **5C**.
		Steering linkage excessively stiff or loose (OK) ▶	REPLACE steering linkage as required.
5C	SPINDLE		
	Check spindle for excessive rotational torque, stiffness, or binding.	Spindle not stiff or binding and rotates with proper torque (OK) ▶	GO to **5D**.
		Spindle rotates with excessive torque, stiff or binding (OK) ▶	REFER to Spindle Rotational Torque in this section, if still not OK, REMOVE and REPLACE ball joints.
5D	TOE SETTING		
	On Groove Feel conditions mainly, check toe setting.	Toe setting to specification (OK) ▶	GO to **5E**.
		Toe setting not at specifications (OK) ▶	ADJUST toe as described in this Section under Front Wheel Alignment in Adjustments.
5E	POWER STEERING CENTERING		
	Check the power steering control valve for centering position.	Power steering control valve not centered properly (OK) ▶	REPLACE power steering control valve.
6	DRIFT/PULL		
	Check tires for conicity (radial tires only).	Tires exhibit no signs of conicity (OK) ▶	GO to **6A**.
		Tires show signs of conicity (OK) ▶	ROTATE tires.

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Tire Non-Uniformity

Tire and Wheel Runout

Excessive radial and lateral runout of a wheel and tire assembly can cause roughness, vibration, wheel tramp, tire wear, and steering wheel tremor.

Before checking runout and to avoid false readings caused by temporary flat spots in the tires, check runout only after the vehicle has been driven.

The extent of runout should be measured with a dial indicator, TOOL-4201-C, Radial Run-Out Gauge 007-00014, or equivalents. All measurements should be made on the vehicle with the tires inflated to

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT	ACTION TO TAKE
6A	TIRE CIRCUMFERENCE		
	Measure and check the circumference of each tire. Tire circumference is usually associated with bias-ply tires and more pronounced on vehicles equipped with limited-slip differentials.	Tire circumference equal (OK) ▶	GO to **6B**.
		Tire circumference unequal (OK) ▶	ROTATE tires. INSTALL the two most evenly matched tires on the rear axle.
6B	CASTER SPLIT		
	Check the vehicle caster reading. Maximum side-to-side variation (split) is 1.5 degrees. **NOTE:** Be sure vehicle loading is balanced "side to side."	Caster within specifications (OK) ▶	GO to **6C**.
		Caster not within specifications (OK) ▶	REFER to Caster Split adjustment in this Section.
6C	TOE SETTING		
	Check that toe is within specifications	Toe setting within specifications (OK) ▶	GO to **6D**.
		Toe settings not within specifications (OK) ▶	RE-ADJUST toe setting to specifications.
6D	FRONT BRAKE DRAG		
	Check the front disc brake systems for brake drag.	No drag in front disc brakes (OK) ▶	GO to **6E**.
		Front brakes drag (OK) ▶	Check for residual line pressure and INSPECT brake calipers. REPAIR as required.
6E	POWER STEERING CENTERING		
	Check that the power steering control valve is centering.	Steering control valve centering properly (OK) ▶	GO to **6F**.
		Steering control valve not centering properly (OK) ▶	REPLACE power steering gear control valve.

CF3920-2D

recommended inflation pressures and with the front wheel bearings adjusted to specifications.

Tire Runout

Measure radial runout of the tire at the center and outside ribs of the tread face (Fig. 6). Measure lateral runout of the tire just above the buffing rib on the tire sidewall (Fig. 6). Mark the high points of lateral and radial runout for future reference. On tires, radial runout should not exceed 1mm (.040 inch), and lateral runout should not be more than 1mm (.040 inch).

Match Mounting Tires

Match mounting is a technique used to reduce radial or lateral tire runouts on tire and wheel assemblies. Excessive runout is a source of ride complaints and match mounting can be used to minimize the runout. There are two ways to use match mounting: 1. positioning of the tire on the wheel; and 2. positioning the wheel on the hub.

1. Measure the total indicated runout on the center of the tire tread rib, and record it. Mark the tire and rim at the center of the tread rib, and record the

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT	ACTION TO TAKE
6F	WHEELBASE MISMATCH		
	Check the vehicle for "dog tracking" to discover wheelbase mismatch. Measurements can be taken from both wheel centers with front wheels in straight ahead position.	Wheelbase does not match (OK) ▶	STRAIGHTEN frame as required. Check rear spring usage side-to-side. REPLACE spring if required.
		Wheelbase matches (OK) ▶	GO to **6G**.
6G	RE-VERIFY CASTER SPLIT		
	Check the vehicle caster reading. A vehicle with a 3/4° split may pull.	Caster split is over 3/4° (OK) ▶	REFER to Caster Split adjustment in this Section.

CF3919-2D

reading. Mark the tire at the location of the valve stem for reference.

2. Break down the tire and remount it 180 degrees on the rim so that the valve stem reference mark is opposite of the valve stem on the wheel.
3. Reinflate the tire and measure the total indicated runout, and again mark the high spot.
4. If the runout is reduced to acceptable guidelines the tire is ready to be put back into service. If the runout is still excessive, one of the following steps must be performed:

- If the high spot is within 4 inches of the first high spot on the tire, and is still outside of guidelines, replace the tire.
- If the high spot is within 4 inches of the first high spot on the wheel, the wheel may be out of tolerance, check the wheel for runout.
- If the high spot is not within 4 inches of either original high spot of the tire and rim, then draw an arrow from the second high spot to the first high spot (in the shortest direction) and rotate the tire on the rim 90 degrees in that direction. This will normally reduce the runout to an acceptable level.

In the majority of cases, the first 180 degrees turn of the tire will either fix the problem or indicate which item to replace.

Tire Imbalance

Tire and Wheel Balance

There are two types of wheel and tire balance: static and dynamic.

A static balance is the equal distribution of weight around the wheel. Wheels that are statically unbalanced cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear (Fig. 7).

A dynamic balance is the equal distribution of weight on each side of the centerline, so that when the tire spins there is no tendency for the assembly to move from side to side. Wheels that are dynamically unbalanced may cause wheel shimmy (Fig. 8).

Deposits of mud, etc., must be cleaned from the inside of the rim. Stones should be removed from the tread. The tire should be inspected for any damage, then balanced according to Ford specifications.

Off-Vehicle Balancing

When balancing wheels off the vehicle, use a balancer which pilots the wheel by the center hole. If the wheel tramp and vehicle vibration is not corrected by the off-vehicle balance, an on-vehicle balance may be needed. Refer to Section 18-01, Noise, Vibration and Harshness.

Tire Conicity

Investigate tire variations. Tires with manufacturing variations cause drift/pull. Problems such as conicity may be encountered with new tires or develop after routine tire rotation or replacement. Conicity is the tendency of a tire to be out-of-round axially as shown in Fig. 9.

Correction Action for the Conicity Issues (for radial tires only)

1. Set all tires to the same air pressure.
2. Exchange front tires, left to right, and right to left. Test drive and evaluate pulling condition.
3. If the pull does not change, the tires are OK. If the pull has been affected, the tires are at fault.
4. Exchange front and rear tires. Test drive and evaluate pulling condition.
5. Substitute spare tire on left front and right front. Test drive after each exchange.
6. Select the best combination of tires noted in Steps 4 and 5.

Tire Circumference Variation

Investigate tire variations. Tires with manufacturing variations cause drift/pull. Problems such as unequal tire circumference may be encountered with new tires or develop after routine tire rotation or replacement.

Corrective Action for Unequal Tire Circumferences (for bias, bias ply, belted tires)

1. Raise the vehicle on a hoist, so all tires are off the ground.

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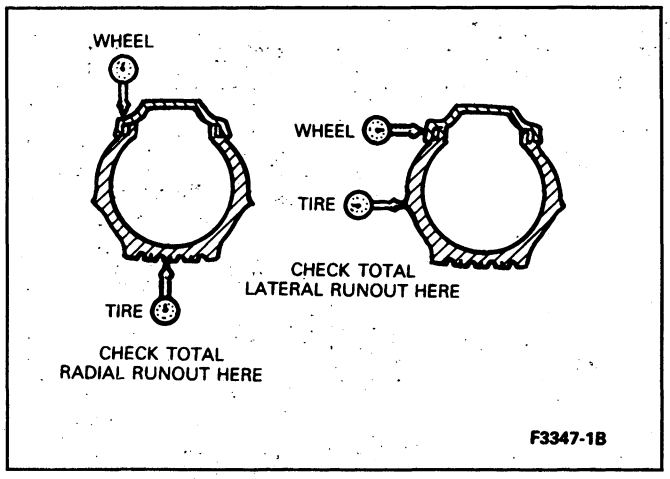


FIG. 6 Radial and Lateral Runout Checks

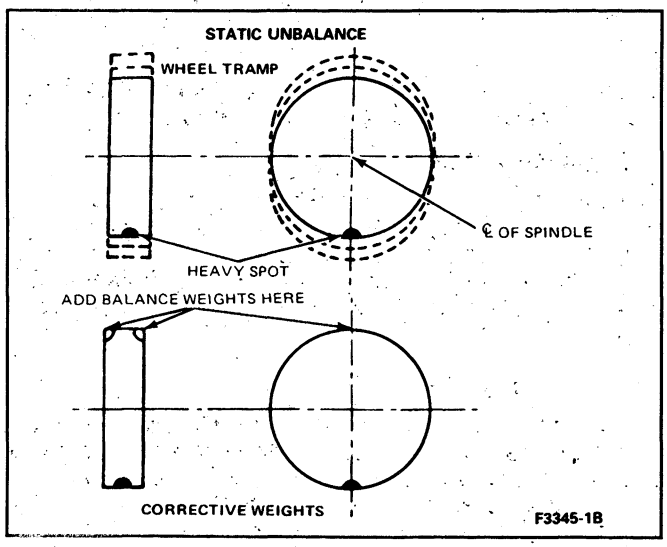


FIG. 7 Static Unbalance

2. Set all tires to the same air pressure, including spare.
3. Measure the circumference of each tire, checking in the middle of the tread. Record circumference of all tires (vehicle will pull towards the side mounted with the smaller tire).

   NOTE: Circumference is easily checked by using a tape measure. Record the reading and proceed to the next tire.
4. For vehicles with locking rear axles, install the two most evenly matched tires on the rear axle.

   NOTE: If the spare tire is new (no miles on the road), it may change size during break-in and require remeasurement to finalize tire matching.
5. Reset tire pressure to vehicle specification.

Wheelbase Mismatch

Check wheelbase mismatch.

Check wheelbase on the left and right side of the vehicle to verify similar side-to-side wheelbases (wheelbase within 1 inch for every 100 inch of W.B.). Measurements should be taken from wheel centers with front wheels straight ahead. It is very important to ensure front wheels are straight ahead when taking wheel base measurements.

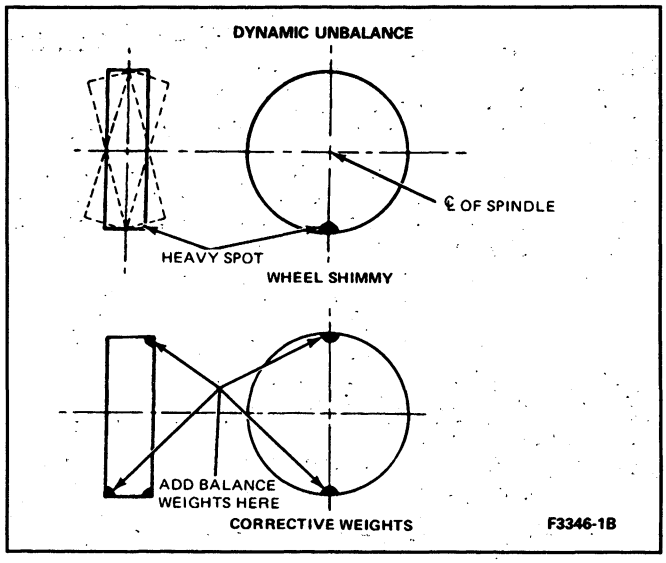


FIG. 8 Dynamic Unbalance

Shock Absorber Checks

The front and rear suspension is equipped with twin tube, low pressure gas shock absorbers. These shocks are of the telescopic double acting type and provide a continuous dampening effect in both compression and rebound modes. The nitrogen gas charge and twin tube construction provide greater damping efficiency and ride comfort. All shock absorbers are ride tuned for specific vehicle applications.

WARNING: THE LOW PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO APPROXIMATELY 930 kPa (135 PSI). DO NOT ATTEMPT TO OPEN.

Before replacing a shock absorber, check the action of the shock absorbers as follows:

On-Vehicle Tests

1. Check the shock absorber to be sure it is securely and properly installed. Check the shock absorber insulators for damage and wear. Replace any worn or damaged insulators and tighten attachments to the specified torque (on a shock absorber which incorporated integral insulators, replace the shock absorbers). Tighten shock absorber attachments to the proper Specifications as listed in the Specifications Section of each suspension group.
2. Inspect the shock absorber for evidence of fluid leakage. A light film of fluid is permissible. Be sure any fluid observed is not from sources other than the shock absorber.

   Replace the shock absorber if leakage is severe.
3. Disconnect the lower end of the shock absorber. Extend and compress the shock absorber using as much travel as possible. Action should become smooth and uniform throughout each stroke. Higher resistance on extension than on compression is a normal condition. Faint swish noises are also normal.
4. If the action is smooth, but the shock absorber is suspected of being weak, follow Step 5.
5. Repeat Step 3 on the mating shock absorber installed on the opposite side of the vehicle, and compare results of both tests. If the action is

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similar, it is unlikely that either shock absorber is worn or damaged. Reconnect both shock absorbers.

6. If there is a difference between the two, replace the shock absorber having the lower resistance. Ensure that the part number of the replacement is the same as that of the original shock absorber. The replacement shock absorber resistance will appear to be higher than either original, due to initial friction of the rod seal.

Install a new shock absorber if any of the following abnormal conditions are met:

1. If the shock absorber is properly primed in its installed position, and there is no resistance occurring near midstroke of the shaft's reverse travel direction.
2. If there is any seizing during the shaft's full travel, except at either-end of the travel.
3. If upon the shaft's reverse stroke, there is any noise encountered other than a faint swish, such as a clicking sound.
4. If there are excessive fluid leaks.

Spindle Rotating Torque

Twin I-Beam Axle With King Pins

E-150—E-350

Check spindle turning torques, with the linkage disconnected as follows:

NOTE: Measure spindle turning force at spindle arm to linkage stud hole.

Apply force to end of spindle arm and rotate back and forth quickly ten (10) times. If over twenty (20) lbs. of force is required to rotate the spindle with a push/pull gauge, or if it grabs or sticks during movement, remove the king pin and clean/remove burrs on spindle bushings and pin. Pre-lube spindle bushings and reassemble as shown in Section 14-21, Front Suspension—Twin I-Beam. Pressure lubricate at both grease fittings and recheck rotational force.

Twin I-Beam Axle With Ball Joints

F-150—F-350 (4x2), F-150—F-250 (4x4) and Bronco

To check spindle turning efforts, disconnect the steering linkage at the steering knuckle. Rotate the spindle back and forth quickly ten (10) times. Push the spindle at the end of the steering arm with a push-pull gauge at one (1) RPM. Multiply the reading by 0.5 to obtain the spindle turning torque in ft-lbs. Maximum spindle turning torque is 20 N·m (15 ft-lbs) for 4x4's and 13 N·m (10 ft-lbs) for 4x2.

If the spindle rotational torque is below the specification, check the steering gear meshload and steering linkage ball stud turning torques (not applicable to vehicles equipped with rubber ball stud linkage). Refer to Group 13—Steering of this Shop Manual for proper diagnosis and repair.

If the spindle rotational torque is above the specified range for ball joint spindle/knuckle systems, perform the following:

- Rotate the spindle back and forth from stop to stop and check for clearance between the spindle and the axle. Interference between the two surfaces will cause the spindle to bind resulting in high turning efforts.
- If no interference exists, perform the following:

F-150—F-250 (4x4) and Bronco

1. Remove the upper ball stud cotter pin and fastener.
2. Use Pitman Arm Puller T64P-3590-F or equivalent with spacer against the end of the stud to break the camber adjuster loose. Leave the nut on the end of the stud if necessary to protect the thread.
3. Measure and record the upper ball joint turning torque as follows:

   Install the castellated nut upside down on the stud and insert the cotter pin. Rotate the stud back and forth quickly ten (10) times.
4. Measure and record the upper ball stud turning torque at 10 RPM using a dial indicator torque wrench. If the torque exceeds 6.7 N·m (60 in-lbs), replace the ball joint as described in Section 14-21, Front Suspension Twin I-Beam of this Shop Manual.
5. Measure and record the lower ball joint turning torque as follows:

   Orientate the front axle shaft U-joint cross between the ball joints such that it is parallel to ball joint studs.

Rotate the spindle back and forth quickly ten (10) times.

Push the spindle at the end of the steering arm with push-pull gauge at 1 RPM. Multiply the reading by six (6) to obtain the lower ball joint turning torque in in-lbs.

6. If the ball joint torque exceeds 6.7 N·m (60 in-lbs), remove the ball joint as described in Section 14-21, Front Suspension Twin I-Beam of this Shop Manual. Then re-evaluate the torque at 10 RPM using a dial indicator torque wrench. Replace if the turning torque exceeds 4.0 N·m (35 in-lbs). If the torque is within specification, inspect the axle shaft U-joint for binding.
7. If replacement ball joints are required, evaluate the torque of each before installation.

NOTE: If the ball joint torques are within specification, high spindle turning efforts are the result of torquing the fasteners out of sequence which preloads the ball joint improperly.

8. Loosen the lower ball joint nut to the end of the stud and strike the spindle near the lower ball joint to break the spindle loose from the stud.

NOTE: The following torque sequence must be followed EXACTLY when securing the spindle.

9. Make sure that the ball joint rubber grease boot is seated at the base of the stud against the socket.
10. Wipe any grease from the studs.
11. Install the steering knuckle and tighten the lower nut to 47 N·m (35 ft-lbs).
12. For all 4x4 vehicles, install the nut and tighten to 136 N·m (100 ft-lbs). Advance the nut to the next castellation and install a new cotter pin.
13. Finish tightening the lower nut to 129-149 N·m (95-110 ft-lbs).

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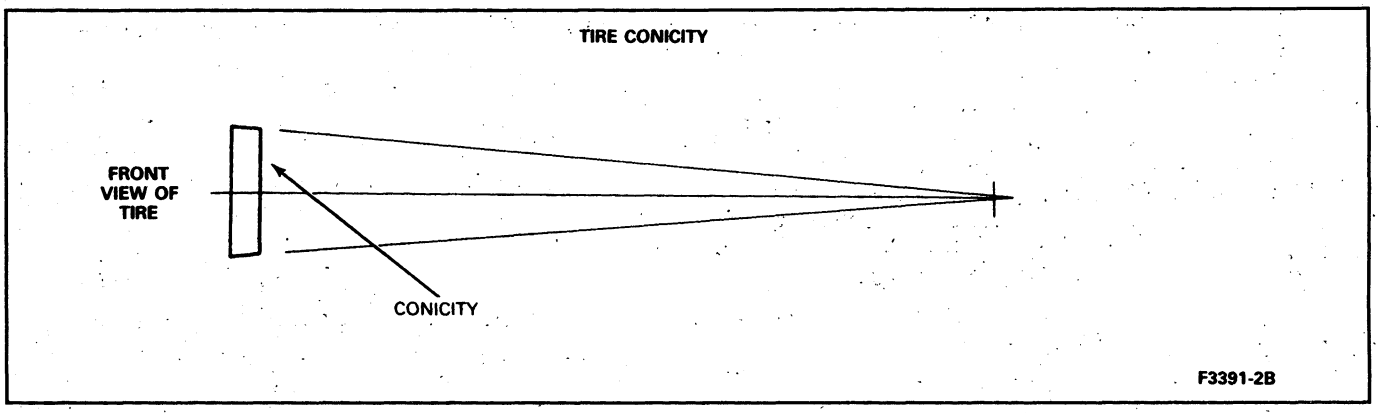


FIG. 9 Tire Conicity

14. The camber adjuster will seat itself into the spindle at a predetermined position during the tightening sequence. DO NOT attempt to adjust this position.
15. Recheck the spindle rotational torque using the push-pull gauge as described above to ensure it does not exceed 34 N·m (25 ft-lbs).

F-150—F-350 (4x2)

1. Measure and record ball joint stud turning torque as follows:
2. Push the spindle at the end of the steering arm with a push-pull gauge at 10 RPMS. Multiply this reading by six (6) to obtain spindle turning torque in in-lbs. Record the reading.
3. Loosen the pinch bolt at the upper ball joint and remove the camber/caster adjuster.
4. Measure the spindle turning torque as described in Step 2 without the camber/caster adjuster. This reading will be lower ball joint stud turning torque.
5. Subtract the lower ball stud torque in Step 4 from the spindle turning torque reading in Step 2. This difference is the upper ball joint stud turning torque.
6. If either ball joint turning torque measurements exceeds 7 N·m (60 in-lbs), replace the ball joint as described in Section 14-21.
7. Measure ball stud turning torque of the replacement ball joint prior to installation. Maximum ball stud turning torque at 10 RPM is 35 in-lbs.

NOTE: If neither ball joint exceeds the stud turning torque specification, high spindle turning efforts is the result of tightening the fasteners out of sequence which preloads the ball joints improperly. Attach the axle and spindle EXACTLY as described below.

8. Wipe any grease from the ball joint studs and ensure the rubber seal is fully seated at the base of the ball stud against the socket.
9. Tighten the lower ball joint fastener to 169 N·m (125 ft-lbs). Advance the castellated nut to install the cotter pin.
10. Install the camber/caster adjuster and tighten the pinch bolt to 75 N·m (55 ft-lbs).
11. Recheck the spindle rotational torque to ensure the maximum 13 N·m (10 ft-lbs) specification is not exceeded.

Attachments and Fasteners

Check the following components with associated brackets, fasteners, and bushings for damage or looseness and service as required:

- Front wheel lug nuts
- Front and rear springs/shocks
- Front/rear suspension components
- Axle and radius arm pivot brackets to frame
- Steering gear to frame
- Pitman arm

Refer to Specifications in the appropriate Shop Manual Section for torque specifications.

Radius Arm Bushing

Check radius arm bushings—worn radius arm bushings can induce shimmy problems. If visual deterioration is apparent, replace per the procedure in the Removal and Installation portion of Section 14-21, Front Suspension—Twin I-Beam, or Section 14-22, Front Suspension—4 Wheel Drive. Ensure plastic spacer is installed between insulator and bracket.

Brake Drag

Inspect brake system for:

- Seized wheel cylinders or calipers.
- Binding/non-releasing brake cables.

SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS

Tool Number	Description
T64P-3590-F	Pitman Arm Puller
T00L-4201-C	Dial Indicator

CF4587-1B

ROTUNDA EQUIPMENT

Model	Description
007-00014	Radial Run-Out Gauge

CF6570-1A

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